Geography 142: Climate Dynamics [4 units]

Fall 2023 (version date: 08/22/23)

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Office hours: TBA (when online: https://berkeley.zoom.us/j/2635155989); or by appointment

GSI: Ankur Mahesh, ankur.mahesh@berkeley.edu
Office hours: in person (McCone 257) and online (https://berkeley.zoom.us/j/4365986851), Monday 9a-10a and Wednesday 3:30-4:30p; or by appointment

The course presents a conceptual basis for understanding of the workings of the climate system, and how they conspire to bring about global climate change change. Covered topics include observations of the climate system; the earth's energy balance; atmospheric radiative transfer; atmospheric circulation; the role of the ocean and the cryosphere; climate variability on various timescales; climate feedbacks and climate change.

A detailed understanding climate dynamics is becoming increasingly necessary as part of an Environmental Science education. The goal is to teach climate dynamics as rigorously as possible, but also recognizing that the audience is now drawn from a wider range of interests, and not necessarily from those with a traditional physics and mathematics background.

Please note that *the course does not cover societal impacts of climate change nor climate change policy* – the focus of this course is on the physics of climate. If you are interested in impacts and policy, there are several courses on campus on those topics. Norm Miller teaches GEOG 149B "Climate Impacts and Risk Analysis" in the Spring semesters.

Instruction consists of two 80-minute lectures a week, and a weekly 1-hour section. There are weekly assignments, a midterm and final exam.

Lecture (in person): Mon and Wed 2p-3:30p @ 145 McCone (*first lecture Wednesday August 23*)

Section (in person): (*starts week of August 28*)

- 101: Mondays 3:30-4:30p @ 145 McCone
- 102: Tuesdays 3:00p-4:00p @ 145 McCone

Course home page: on bCourses, http://bcourses.berkeley.edu. Lecture slides will be posted on bCourses the night before the lecture. It'll usually be late at night, so check in the morning prior to class. I will also post PDF of required readings that are not in the required textbook.

Prerequisites: Concepts in physics are used in the text, so knowledge at the level of first course in undergraduate physics is recommended; you should have at least taken physics at high school level. Basic calculus will be helpful, though not assumed. A questionnaire will be handed out to gauge your background in physics and mathematics. Please read the separate note at the end of this document on prior preparation for guidance and contact the instructor if you have questions about your suitability to take this course.

Weekly assignments will be online using gradescope and handed out on Fridays (and possibly a day

before). Due Monday week **at 11am** (i.e. not the following Monday, but the Monday after that)
Weekly sections. The GSI will address the prior week's material, and the current assignment. Please review the lecture slides/notes and assignment prior to attending.

Exams will be conducted in-person and will be a timed exam, closed book and closed notes.

- Midterm – in person during class time on Monday October 9
- Final exam – in person during exams week; exact date TBA

Grading (weightings subject to change):

- weekly assignments (40%), 11 graded sets, 5% each, lowest 3 dropped
- Midterm exam (up to 25%)
- Final exam (up to 35%)
- Quickwrites (around 7-8 for the semester. Each quickwrite credit earned will decrease the total exam weighting by 1%)

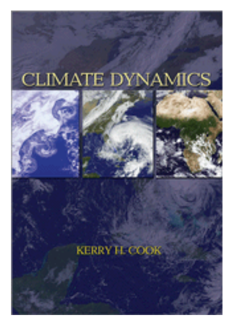
Course requirements

- Taking the midterm and final exams are required to pass the course.
- Attending lecture and completing all assignments

Course Expectations

- Adhere to the Academic Code of Conduct: *"As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others".* See the next page for the statements on academic integrity.
- Attend all lectures and sections, and be punctual
- Check bcourses regularly for announcements and reading materials
- Keep up with the readings and lecture material
- Participate and ask questions!

Required Text
'Climate Dynamics' by Kerry H Cook, Princeton University Press (2013).
Cal Store (ebook)
https://calstudentstore.berkeley.edu/ebook/9781400847334
E-reserves (unlimited)
https://libproxy.berkeley.edu/login?qurl=https%3A%2F%2Fwww.jstor.org%2Fstable%2F10.2307%2Fj.ctv30pnvrh



The course also uses portions of these texts (PDF of relevant sections will be provided on bcourses)

- J.D. Neelin, 'Climate Change and Climate Modeling' (Cambridge Press, 2011)
- D. Hartmann, 'Global Physical Climatology' (Academic Press, 1994)
- J. M. Wallace and P.V. Hobbs, 'Atmospheric Science: An Introductory Survey', 2nd Edition. (Academic Press, 2006)
- L. R. Kump, J. F. Kastings and R. G. Crane, 'The Earth System', 3rd Edition (Pearson Prentice Hall)

Geography 142 course schedule – Fall 2023 (subject to change)

Week	**Monday lecture**	**Wednesday lecture**	**Assignment (handed out Thursday)**	**Notes**
1 (8/21)		1. Introduction		No section this week
2 (8/28)	2. Observations of the climate system 1 (KC2.1 and 2.3)	3. Observations of the climate system 2 (KC2.1 and 2.3)	#1	
3 (9/4)	Academic holiday	4. Global Energy Balance (KC 4.1-4.4)	#2	9/4 holiday
4 (9/11)	5. Greenhouse effect (KC 4.1-4.6, Neelin 2.3)	6. Radiative Transfer and the role of clouds (KC 4.6-4.7)	#3	
5 (9/18)	7. Atmospheric Convection (Hartmann 3.10, Wallace and Hobbs 2.5-2.7)	8. Heat flows of Earth; hydrostatic balance (KC 5.3, Hartmann 2.9)	#4	
6 (9/25)	9. Momentum conservation (KC Ch6)	10. General circulation (Hildore reading; Hartmann 6.3, KC 6.4 and Ch7.1)	#5	
7 (10/2)	11. Regional climates (KC Ch7 and Seager reading)	12. Midterm Review	No assignment	
8 (10/9)	**Midterm**	13. Hurricanes ("Hurricane Basics", a NOAA publication)	#6	No section this week
9 (10/16)	14. Ocean circulation 1 (KC 2.2, 8.1, 8.3)	15. Ocean circulation 2 (KC 8.1, KKC Ch 5, Hartmann 7.8.1)	#7	
10 (10/23)	16. Thermohaline circulation and climate (KKC Ch 5, Rahmstorf reading)	17. El Nino-Southern Oscillation (Neelin section 1.5, and 4.1-4.8)	#8	
11 (10/30)	18. Climate Feedbacks 1 (Neelin 6.1-6.3)	19. Climate Feedbacks 2 (Neelin 6.3-6.8)	#9	
12 (11/6)	20. Climate Models (Neelin 5.1,5.5,5.6)	21. Cryosphere (KKC Ch6)	#10	11/11 holiday
13 (11/13)	22. Global Warming 1 (Archer, Ch11; Neelin 7.6)	23. Global warming 2 (Neelin 7.1-7.3)	#11	
14 (11/20)	No class	Thanksgiving		No section this week
15 (11/27)	24. Global warming 3 (Houghton pp172-187; Hausfather pp1-8)	26. Final Exam Review	No assignment	
16 (12/4)	RRR week			
17 (12/11)	**Final exam** week			

- KC = Kerry Cook, *Climate Dynamics*
- KKC = Kump Kastings and Crane, *The Earth System*

Academic Integrity

Please read the statements below on our expectations of you. They are taken from the *Berkeley Center for Teaching and Learning* (https://teaching.berkeley.edu/statements-course-policies)

“You are a member of an academic community at one of the world’s leading research universities. Universities like Berkeley create knowledge that has a lasting impact in the world of ideas and on the lives of others; such knowledge can come from an undergraduate paper as well as the lab of an internationally known professor. One of the most important values of an academic community is the balance between the free flow of ideas and the respect for the intellectual property of others. Researchers don't use one another's research without permission; scholars and students always use proper citations in papers; professors may not circulate or publish student papers without the writer's permission; and students may not circulate or post materials (handouts, exams, syllabi--any class materials) from their classes without the written permission of the instructor.”

“Any test, paper or report submitted by you and that bears your name is presumed to be your own original work that has not previously been submitted for credit in another course unless you obtain prior written approval to do so from your instructor. In all of your assignments, including your homework or drafts of papers, you may use words or ideas written by other individuals in publications, web sites, or other sources, but only with proper attribution. If you are not clear about the expectations for completing an assignment or taking a test or examination, be sure to seek clarification from your instructor or GSI beforehand. Finally, you should keep in mind that as a member of the campus community, you are expected to demonstrate integrity in all of your academic endeavors and will be evaluated on your own merits. The consequences of cheating and academic dishonesty—including a formal discipline file, possible loss of future internship, scholarship, or employment opportunities, and denial of admission to graduate school—are simply not worth it.”

"**Collaboration and Independence**: Reviewing lecture and reading materials and studying for exams can be enjoyable and enriching things to do together with one’s fellow students. We recommend this. However, homework assignments should be completed independently and materials turned in as homework should be the result of one’s own independent work. Some assignments, namely the preparation for the debate arguments, are meant to be done together in a group.”

“Cheating: Anyone caught cheating on a quiz or exam will receive a failing grade and will also be reported to the University Office of Student Conduct. In order to guarantee that you are not suspected of cheating, please keep your eyes on your own materials and do not converse with others during the quizzes and exams.”

Geog 142 (Climate Dynamics)   Note regarding prior background for the course

I often get asked about prerequisites for taking this course. I hope the below helps.

1. If you have a strong physics and/or mathematics background

What I mean by 'strong' are the first courses in undergraduate physics (classical mechanics, electromagnetism, waves) and mathematics up to multivariate calculus and some exposure to ODEs and PDEs.

You're possibly a physics/chemistry/mathematics/engineering student curious about how you can use your knowledge in an applied environmental field.

This course won't be 'difficult' from a physics or mathematics viewpoint. If you are looking to start from basic physical principles and solve equations, The 'Atmospheric Physics and Dynamics' course (Geog C139 / EPS C181) would be more appropriate.

Nevertheless, I do think you'll learn something from this course. The course aims to give a conceptual basis of how climate works. You need to know the gross structure of the atmosphere and ocean. This holistic view is not emphasized as much in the 'Atmos Physics and Dynamics Course', since that course is more reductionist.

The roots of climate science are empirical – observations usually came first, before theory. This is still very much true for a lot of what climate scientists do today.

2. If you don't have a strong physics or math background

You might have taken physics and calculus in high school but haven't used it over the years. Or, you may not have taken calculus at all.

You're possibly a philosophy/economics/political science major interested in climate change. Or a biology major who has taken some physics and mathematics somewhere along the line, but have not used it much.

With this course, I emphasize the conceptual aspects of climate. Climate science is, however, a physical science – you can't avoid the physical basis. And the natural language for physics is mathematics. That is why a first course in undergraduate physics is recommended, and that basic calculus is helpful.

I do introduce equations and expect you to be able to do algebraic manipulations and relatively simple numerical calculations**. If you have no exposure whatsoever to algebra and physics, I do not recommend you take this course.**

That being said, this is not a course about solving equations. It is about giving a holistic overview of the climate system. Climate science is rooted in empiricism – a lot of what you need to know about climate is from observations.

What I have found in the past is that students that do well in the course are those with a curiosity about the natural world, coupled with a strong physical intuition and a good work ethic. Some of the best students were philosophy and political science majors (one became my graduate student).

However, these are hard to quantify in terms of 'prerequisites'. The only thing I can suggest is for you to look at the textbook and judge for yourself.