

Course Syllabus

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Course description: This course examines the processes that determine the structure and circulation of the Earth's atmosphere. The approach is deductive rather than descriptive: to figure out the properties and behavior of the Earth's atmosphere based on the laws of physics and fluid dynamics. Topics will include interaction between radiation and atmospheric composition; the role of water in the energy and radiation balance; governing equations for atmospheric motion, mass conservation, and thermodynamic energy balance; geostrophic flow, quasigeostrophic motion, baroclinic instability, and dynamics of extratropical cyclones.

Location & time: Mondays and Wednesdays, 2-3:30 pm, McCone 325

Instructor: William Boos, william.boos@berkeley.edu, (<mailto:william.boos@berkeley.edu>) office McCone 413, phone 510-664-5098

Reader: Wenwen Kong, wenwen.kong@berkeley.edu (<mailto:jakeyung@berkeley.edu>)

Office Hours:

Wed. 3:30 - 4:30 pm in 325 McCone with William Boos

Thurs. 12:30 - 1:30 pm in 404 McCone with Wenwen Kong

Course texts:

Our primary course text is *Atmosphere, Ocean, and Climate Dynamics* by Marshall and Plumb. This is an introductory, vector calculus-based textbook targeted at upper-level undergraduate and beginning graduate students. I strongly encourage you to purchase a physical copy of this book, but it is available as a free e-book through the Berkeley library. We will also use a selection of readings from several texts noted below.

Primary text: (MP) *Atmosphere, Ocean, and Climate Dynamics*, Marshall and Plumb, 2008. [E-book available \(http://site.ebrary.com/lib/berkeley/Doc?id=10378944\)](http://site.ebrary.com/lib/berkeley/Doc?id=10378944) through Berkeley library.

Supplementary texts:

(WH) *Atmospheric Science: An Introductory Survey*, by Wallace and Hobbs, second edition, 2006. [E-book available \(http://www.sciencedirect.com/science/book/9780127329512\)](http://www.sciencedirect.com/science/book/9780127329512) through Berkeley library.

(Vallis) *Essentials of Atmospheric and Oceanic Dynamics*, by Vallis, 2019

(Hartmann) *Global Physical Climatology*, by Hartmann, second edition, 2016

(HH) *An Introduction to Dynamic Meteorology* by Holton and Hakim. [E-book available \(http://www.sciencedirect.com/science/book/9780123848666\)](http://www.sciencedirect.com/science/book/9780123848666) through Berkeley library.

Prerequisites: The course requires basic familiarity with multivariate calculus, partial differential equations, and introductory physics. These topics are all covered in the official prerequisites of Math 53, 54 and Physics 7A-7B-7C. In practice, your math background should be fine if you are comfortable *using* basic

vector calculus (e.g. gradient, cross product, and curl operators); you will not be asked to solve complicated partial differential equations.

Grades will be based on three exams (60%), frequent in-class quizzes (20%), and homework (20%). The first two (in-class) **exams** will each be worth 17.5% of the total course grade, and the final exam will be worth 25%. The in-class exams will be on Oct. 1 and Nov. 5. Berkeley has assigned the time of 3 - 6 pm on Thursday, Dec. 19, 2019 for the final exam. **Quizzes** are given approximately once each week, and typically take only 3-5 minutes. Some quizzes will use the interactive PollEverywhere software which allows you to respond via a website (from your laptop or smart phone) or a simple text message (sent by a 'dumb' phone); you can take a quiz by going to <https://pollev.com/williamboos> or <https://pollev.com/williamboos> or texting WILLIAMBOOS to 37607 (these will only work during class when a quiz is in progress). We will drop the lowest 4 quiz scores, which allows for an occasional absence, technical difficulty with the quiz software, etc. **Homework** will typically be due by 2:10 pm on Fridays, allowing you to attend office hours 1-2 days before that due date. Note that we do not have class on Fridays, so you must either submit the homework to my mailbox on the 3rd floor of McCone Hall, submit it electronically via bCourses, or submit it in class before the due date. Solutions to each homework will be distributed the Monday after homework is due; no late homeworks will be accepted after solutions are distributed, and 20% of a full score will be deducted for homeworks submitted after the Friday 2:10 pm due date. Homework is graded only based on whether you demonstrate a legitimate attempt to write answers to the problem set (i.e. you do not need to obtain the correct answer to get full credit).

Course website: bCourses

Academic integrity: All students are expected to be familiar with and to adhere to common standards of academic integrity, as outlined in the Berkeley campus code of student conduct. Please be aware that faculty are asked to refrain from adjudicating cases of academic dishonesty privately, and to refer all cases to the Center for Student Conduct.

Policy on electronic devices: Please do not use cell phones, tablets, or computers for any purpose other than to participate in class. Your use of an electronic device during class time for a non-class purpose can be distracting to others and inhibit their learning process.

Attendance and missed classes: I do not take attendance or apply grade penalties for missing class, but I do verbally communicate a substantial amount of course content and logistical details during class. It is your responsibility to stay up-to-date on all such communications. *If you miss a class, please ask other students for notes and any logistical updates before coming to see me.* Absences may also cause you to miss quizzes; as mentioned above, I drop several of the lowest quiz grades to compensate for the occasional illness, etc.

On confidential discussions: Please feel free to come and talk with me about any issues that may affect your education, whether they occur in this class, at Berkeley, or elsewhere. My door is always open and I will make every effort to maintain confidentiality as appropriate. That said, be aware that I am a "responsible employee" under Title IX, and I am required to inform the campus Title IX officer if I become aware that a student has experienced sexual harassment or sexual violence (including sexual assault, domestic violence and stalking).











Detailed syllabus (subject to change):







Date	Major theme	Detailed topics	Readings (complete by the date listed)
Aug-28	0. Course overview	The global structure and evolution of atmospheres; the problem of understanding weather & climate.	MP Chapter 1 and WH Chapter 1
Sep-4	1. The basics: conservation of mass, energy, and momentum	Conservation principles in fluids; the non-rotating momentum equation	MP 6.1-6.2. Optional: Vallis 1.1 - 1.3
Sep-9		Hydrostatic balance, the ideal gas law, scale height; mass conservation	MP Chapter 3, 6.3. Optional: Vallis 1.4-1.5
Sep-11		Conservation of energy; flux form of conservation equations	MP 4.3
Sep-16	2. Thermodynamics	Thermodynamic equation, potential temperature	
Sep-18		Pressure coordinates	MP 6.4-6.5, 5.2
Sep-23		Buoyancy, dry adiabats, static stability	MP Chapter 4 through 4.2.3
Sep-25		Gravity waves	MP 4.4, HH 5.1-5.3.1
Sep-30		Moist thermodynamics: measures of water content, saturation, condensation, moist adiabats	MP 4.5
Oct-2		----- Exam 1 -----	
Oct-7		Moist soundings, skew-T diagrams, moist conserved variables; dry and moist	MP 4.6-4.7; WH 3.5.1-3.5.4; Skew-T tutorial

		convection, their implications for atmospheric structure	
Oct-9	3. Radiation	Blackbody radiation, Earth's radiative flux density	MP Chapter 2
Oct-14		Geometry of radiation, Kirchhoff's Law	MP 5.1
Oct-16		Simple models of the greenhouse effect	Hartmann 2.3.2-2.5
Oct-21		Wavelength-dependent absorption and scattering, Schwarzschild's equation	Hartmann Chapter 3
Oct-23		Observed distributions of radiative fluxes	
Oct-28	4. Large-scale dynamics	Transforming the momentum equation to a rotating frame	HH 2.1-2.2, MP 6.6.2
Oct-30		Centrifugal, centripetal, and Coriolis forces	MP 6.6.3, 6.6.4
Nov-4		----- Exam 2 -----	
Nov-6		The Rossby number, geostrophic balance, streamfunctions	MP 6.6.1, MP chapter 7 through 7.1.3; HH 2.4
Nov-13		Thermal wind balance, gradient wind balance	MP 7.2-7.3.2, 7.3.5, and section 7.4 through 7.4.2
Nov-18		Ekman flow, Hadley cells, the observed global circulation	MP 7.4.3, 5.3-5.4, chapter 8 through 8.2.1
Nov-20		Rossby deformation radius, geostrophic adjustment	MP 7.3.3, 7.3.4
Nov-25		Angular momentum conservation, jet streams, eddy momentum fluxes	MP 8.2.2-8.3.2

Dec-2		Baroclinic instability, isentropic upglide, east coast cyclogenesis	MP 8.3.3-8.5
Dec-4		Long-term trends and interannual variability in climate: dynamic and thermodynamic changes	
Dec-19		---- Final exam, 3-6 pm ----	

Course Summary:

Date	Details	
Wed Sep 4, 2019	 Quiz 1 (https://bcourses.berkeley.edu/courses/1484483/assignments/8016237)	due by 2:15pm
Mon Sep 9, 2019	 Quiz 2 (https://bcourses.berkeley.edu/courses/1484483/assignments/8023667)	due by 3:30pm
Fri Sep 13, 2019	 pset1 (https://bcourses.berkeley.edu/courses/1484483/assignments/8019953)	due by 2:10pm
Wed Sep 18, 2019	 Quiz 3 (https://bcourses.berkeley.edu/courses/1484483/assignments/8025267)	due by 2:10pm
Fri Sep 20, 2019	 pset2 (https://bcourses.berkeley.edu/courses/1484483/assignments/8023520)	due by 2:10pm
Fri Sep 27, 2019	 pset3 (https://bcourses.berkeley.edu/courses/1484483/assignments/8025618)	due by 2:10pm
Mon Sep 30, 2019	 Quiz 4 (https://bcourses.berkeley.edu/courses/1484483/assignments/8026888)	due by 2:10pm
	 Skew T tutorial (https://bcourses.berkeley.edu/courses/1484483/assignments/8026115)	due by 2:10pm
Wed Oct 2, 2019	 Exam1 (https://bcourses.berkeley.edu/courses/1484483/assignments/8028826)	due by 3:30pm
Fri Oct 4, 2019	 pset3 - the second part (https://bcourses.berkeley.edu/courses/1484483/assignments/8028848)	due by 2:10pm

Date	Details	
Mon Oct 14, 2019	 pset 4 (https://bcourses.berkeley.edu/courses/1484483/assignments/8029375)	due by 2:10pm
	 Quiz 5 (https://bcourses.berkeley.edu/courses/1484483/assignments/8029374)	due by 2:10pm
Wed Oct 16, 2019	 Exam 1 revisions (https://bcourses.berkeley.edu/courses/1484483/assignments/8029579)	due by 2:10pm
Fri Oct 18, 2019	 pset 5 (https://bcourses.berkeley.edu/courses/1484483/assignments/8030570)	due by 2:10pm
Mon Oct 21, 2019	 Quiz 6 (https://bcourses.berkeley.edu/courses/1484483/assignments/8031294)	due by 2:10pm
Mon Oct 28, 2019	 pset 6 (https://bcourses.berkeley.edu/courses/1484483/assignments/8032567)	due by 2:10pm

