

# Syllabus for ATOC1060: Our Changing Environment

Baylor Fox-Kemper

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## 1 Contacts

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- **Teaching Assistant:** Benjamin Blazey, [benjamin.blazey@colorado.edu](mailto:benjamin.blazey@colorado.edu)
- **Website:** <http://fox-kemper.com/1060>, username: `atoc1060`, password: `IC`
- **Office Hours:** Prof. Fox-Kemper's office hours are Mondays 1:30-3:30PM in Ekeley S250B or by appointment ([bfk@colorado.edu](mailto:bfk@colorado.edu)). TA Ben Blazey's office hours are Mondays 5-7PM in Duane E126 or by appointment ([benjamin.blazey@colorado.edu](mailto:benjamin.blazey@colorado.edu)). Students are encouraged to seek homework help at these times.

## 2 Course Description

- Prerequisites: ATOC1050
- Approved for arts and sciences core curriculum: natural science (3 credits)
- Elective for ATOC minor

Discusses the Earth's climate for non-science majors, focusing on the role of the atmosphere, oceans, and land surface. Describes the water cycle, atmospheric circulations, and ocean currents, and how they influence global climate, El Niño, and the ozone hole. Discusses human impacts from climate change.

## 3 Meetings and Places

The course will meet in Duane G1B20, 12:30-1:45PM on Tuesdays and Thursdays. Prof. Fox-Kemper's office hours are Mondays 1:30-3:30PM in Ekeley S250B or by appointment [bfk@colorado.edu](mailto:bfk@colorado.edu). Teaching Assistant Ben Blazey's office hours are Mondays 5-7PM in Duane E126 or by appointment [benjamin.blazey@colorado.edu](mailto:benjamin.blazey@colorado.edu). Quantitative problem sessions are also during this Monday 5-7 time.

## 4 Goals

In this class you will attend 3 hours of lecture and related to the Earth's Environment and Climate. You will also:

- Meet other interested and interesting students
- Learn about the geological, chemical, physical, and biological processes and their role in components of the Earth system
- Learn about how the Earth system has changed in the past and may change in the future
- Learn about human impacts on Earth's climate and climate's impacts on humans
- Learn how quantitative scientific methods and thinking are applied and how they differ from non-scientific approaches
- Become 'Climate Literate': you will have the knowledge and skills to comprehend discussions on climate from sources such as the New York Times science page and DotEarth blog, the IPCC report summaries, the RealClimate blog, and Scientific American.
- Be able to answer the IPCC Frequently Asked Questions about Climate
- <http://www.ipcc-wg1.unibe.ch/publications/wg1-ar4/ar4-wg1-faqs.pdf>
- Be prepared for upper division classes in Atmospheric and Oceanic Sciences

## 5 Grading

Grading: 45% homework, 25% final exam, 15% midterm exam, 15% clicker questions. Letter grades for exams will be based on class-wide curves. Homework and clicker questions will not be curved, but your lowest homework assignment grade will be dropped and perfect clicker attendance is not required.

## 6 Attendance

It is expected that students will attend all lectures if possible. Material required for homework and the final exam may be presented in lectures and not elsewhere. Lecture slides are available on the website after each class but may not contain all information presented in class. Full credit will be given for a score of 85% on clicker questions over the course of the semester or above. The lowest homework assignment will be dropped. These policies accommodate the majority of absences or technical glitches with clickers or CULearn. Additional valid absences must be excused by email from the professor *in advance of the missed class or assignment*, in which case missed clicker credit may be excused (dropped from the average) and extensions or additional dropped assignments may be granted. Reasons for valid absences are according to CU policy are given below and include illness, family emergencies, religious observation, and athletic events. Appropriate documentation is required. The midterm and final exam may not be dropped or excused.

### 6.1 Alerting the Professor of Clicker Issues, Planned Absences, etc.

Do not rely on verbal exchanges with the professor or TA. *Always send an email detailing your issue, and if you do not receive a reply then resend or contact the professor by other means.* Without email evidence, no adjustments to grades will be made and no absences will be excused. If your clicker is lost or dies, an email with your intended click-in answers is acceptable on rare occasion.

#### 6.1.1 Clicker Registration, Waiting Lists, and Administrative Drops

Clickers will be used for credit in class beginning the second week of class. The first homework will also be due the second week of class. During the third week of class, any student missing the first and second homework and having no registered clicker entries will be administratively dropped from the course to make room for those on the waiting list. Those on the waiting list who have turned in assignments and registered clicker entries at this time will receive priority.

## 7 Textbooks and Reading

The official textbook for the class is Kump, Kasting and Crane's *The Earth System*, third edition, abbreviated by KKC on the webpage and elsewhere. A few chapters and pamphlets outside of KKC are required reading as well, they are indicated and freely available on the webpage.

Each reading assignment goes along with the lectures that week as well as a CULearn homework assignment. It is intended that you read the chapter along with the lectures, and then finalize each week's learning by completing the homework.

### 7.1 How to Read Science

A few comments on 'reading' a scientific article or textbook. Scientific knowledge is not linearly arranged from one idea to the next to the next to the end. Instead, it has a web-like structure with facts clustering to support or be explained by key theories or concepts that connect pieces together. Thus, reading the textbook chapters front to back may not be the most efficient or effective way to absorb information. I suggest that you take this opportunity to learn to skim and then absorb scientific writing. You will find that you will be able to read through more quickly and understand more if you have a good idea what will be covered before you start reading. A guide on how to do this is here:

[http://cires.colorado.edu/science/groups/foxkemper/classes/ATOC1060\\_11/notes/readingprimer.pdf](http://cires.colorado.edu/science/groups/foxkemper/classes/ATOC1060_11/notes/readingprimer.pdf)

## 8 Assignments and Exams

### 8.1 Weekly Homework on CULearn

Most weeks a homework assignment is due on CULearn (<http://culearn.colorado.edu>). A calendar of due dates is on the website and CULearn. As a registered student, you should be able to log into CULearn with your normal

CU identikey.

You may use your textbook, notes, the web materials, etc., to answer the questions on CULearn. You may also discuss the chapters and CULearn questions with your study partners. However, you are bound by the CU honor code that you answer the CULearn questions *on the basis of your own understanding and you must input your own answers*. You will not learn anything or respect the honor code if you take another student's word for it or copy their answer without understanding the question and why you should answer as you do. Questions will not be numbered consistently between different students and each student may receive different questions.

I will mention a few notes on CULearn timing. You may begin an assignment and save your progress without completing it (just don't click on 'Finish', but do click on 'Save'). You may submit an assignment as early as you like if you expect that other classwork, etc. will interfere near the due date. Generally the CULearn assessments should be posted at least two weeks before they are due. When you are sure you are done with the homework, you should click 'Finish' in CULearn. If you forget to click finish, we can do it for you—no problem. If you do click finish before you're done, it's a bit complicated to reset and you are unlikely to get the same questions again. Late homework will not be accepted.

You will also see some running grade averages in CULearn. The **Clickers (w/o skips)** is your raw clicker score, which is just the percentage of clicker points you've gotten out of the questions answered. The **Clickers (with skips)** is your clicker score boosted by the allowed absences. This score may be above 100%, which just means that you have a margin of absences remaining before your clicker score drops below 100%. Likewise, the **HW (w/o skips)** is your raw homework score, which is just the average of your HW problem sets to date. The **HW (with skips)** is an *estimate* of your HW score boosted by dropping the lowest score. At the beginning of the semester, this will be a poor estimate—somewhat higher than the average of your scores dropping the lowest one, but as the semester proceeds it will get closer to being correct. Once all of the HW grades are in, it will be the correct HW score dropping the lowest score.

The factual content of questions will be drawn from the reading and the lecture slides, but this class is not just a presentation of facts about the Earth, it is an opportunity to learn about the nature of science—in particular, the nature of observational, Earth science. This kind of science used to be called 'natural philosophy', as it really is a development of ways of thinking (that is, a philosophy) for understanding and connecting ideas about the natural world. The homework questions will be structured to develop and encourage your own 'natural philosophy' based on scientific thinking about the natural world and its processes, as well as testing your increasing knowledge of facts about the ocean. Thus, problem solving, quantitative skills, critical thinking, determining whether hypotheses and observations are consistent, etc. will be featured along with simple validation that you grasp key concepts, terms, and facts that our understanding of the ocean builds on. Some basic math and equation manipulation will be required for some questions, and knowledge of basic concepts from chemistry, physics, and biology will be expected, too (like atoms, molecules, energy, species, cells, ecosystems, etc.).

## 8.2 iClickers

The use of clickers (iClicker, <http://www.colorado.edu/its/cuclickers/students>, available at the CU Bookstore) is intended to promote student learning by informing the professor what the students are thinking, and by providing a forum for students to learn from each other. The clicker technology allows for the engagement of all students, allows for increased course-related communication between students, and facilitates the feedback loop between students and professor. Most lectures will require you to answer several questions using the clicker, typically as new concepts arise in class. You will receive at least two points for answering the question, plus (usually) one additional point for a correct answer if there is a single correct answer. The clicker question will be denoted (2+1) if there is a correct answer, it will be denoted (2) if there is no correct answer or you are being encouraged to guess.

The dropped low clicker scores are intended to cover those days when your clicker is misplaced or out of order, and days when you cannot attend class for whatever reason. You may also receive clicker credit for valid absences approved *in advance by email*. Clicker questions will start in lecture the second week of class.

### 8.2.1 Clicking for a Friend

Do not click in for a friend who is absent. It is a clear violation of the CU Honor Code. Last year, in an ATOC class, students were required to match their IDs to their clickers as they left the lecture. Students with unaccounted click-ins were therefore caught cheating and failed the course. I may repeat this check without further warning.

## 8.3 Exams

A midterm exam will be given at the scheduled time (Thurs. March. 17, 12:30-1:45PM). For the vast majority of cases, the midterm exam cannot be rescheduled, but disabilities can be accommodated with appropriate documentation. A missed midterm exam will reduce your final grade to a B- or lower. Half of the midterm exam will be

similar to the multiple-choice homework questions, and the other half will require short answers or drawing figures to demonstrate a grasp of conceptual materials.

A final exam will be given at the scheduled time (Tuesday, 5/3, 4:30-7PM). For the vast majority of cases, the final exam cannot be rescheduled, but disabilities can be accommodated with appropriate documentation. A missed final exam will reduce your final grade to a C- or lower. Half of the final exam will be similar to the multiple-choice homework questions, and the other half will require short answers or drawing figures to demonstrate a grasp of conceptual materials.

Both exams will be closed book, but you may bring 1, 2-sided, letter-paper-sized study sheet. You should make your own sheet or collaborate with a friend—it's a really good way to learn!

## 9 Critical Concepts

Earth science is not just about facts and figures. Below are some fundamental concepts that form the core of the science that you must learn in order to understand the basic processes operating in the Earth system. These concepts by no means cover everything that you are expected to learn, but rather form a foundation of fundamental principles and ideas. Some of these concepts will probably be familiar to you, but perhaps their application to Earth will be new. You will find that many of the concepts are applicable to multiple aspects of what we discuss, and will appear repeatedly during the course. These concepts would be conveyed by any professor teaching this class.

1. Density stratification: Explain the layering of the Earth's interior, ocean, or atmosphere as a function of composition, temperature, and pressure. Describe the behavior of neutrally buoyant material. Explain how stable stratification limits vertical motions and may support waves.
2. Convection: Describe the conditions necessary for the development of a convection cell. Identify the driving forces behind convection of the mantle, ocean, and atmosphere.
3. Electromagnetic Radiation: Describe the fate of electromagnetic radiation as it enters the ocean or atmosphere or hits clouds or land or is emitted from a warm body. Relate these fates to the Greenhouse effect, and how the climate system modulates the temperature of the earth. Explain how different colors/wavelengths of light behave differently.
4. Tracer transport and air/water masses: Explain how surface forcing imparts chemical tracers to water masses (salinity, temperature, density, silicate, oxygen, CFCs, tritium, etc.) and how they spread through the atmosphere or ocean. Explain how tracers indicate water or air masses and processes.
5. Heat and temperature: Distinguish between temperature and heat. Explain why water has a high heat capacity. Appraise the importance of water's high latent heats of fusion and vaporization in moderating Earth's temperature.
6. Moist and dry air: Explain how moisture affects convection, how clouds are produced, and the role of latent heat in energy transport.
7. Energy in the Earth system: Describe the sources, sinks, transport, conversion, and effects of energy on Earth.
8. Isostatic equilibrium: Explain how isostatic equilibrium accounts for variations in surface topography with crustal density and thickness, the existence of ocean basins, the buoyancy of icebergs and ships, and the lack of sea level rise from melting floating ice.
9. Coriolis effect: Illustrate why Coriolis deflection is said to depend on the frame of reference. Describe how the direction and magnitude of the Coriolis effect vary with latitude and velocity.
10. Geostrophic flow: Draw vectors to illustrate the balance of the pressure gradient force and Coriolis, with geostrophic flow, around a pressure high or low.
11. Ekman flow: Draw vectors to illustrate the balance of the wind stress and Coriolis. Show how variation in the wind can lead to converging or diverging Ekman flow and coastal or equatorial upwelling.
12. Meridional Overturning: Explain the structure, forcing, and effects of meridional overturning in the atmosphere and ocean circulations. Describe how surface conditions affect masses and air-sea exchange. Describe the ocean and atmosphere structures that accomplish meridional heat and freshwater transport.
13. Waves and Currents: Explain what a wave is. Explain what a current is. How do they differ in time? In transport of air or water? In transport of sediments and tracers?

14. Steady state and residence time: Describe the conditions that must be met under the assumption of steady state for a given substance. Predict how residence time would vary with input/output rate and concentration.
15. Timescales: Describe how systems that appear statistically stable on one timescale may be variable over longer or shorter timescales. Apply this approach to contrast Earth's history, climate, and weather.
16. Stable and unstable equilibria: Describe how positive/negative feedback mechanisms stabilize/destabilize perturbations from equilibrium states and the consequences for system response to external forcing.
17. Quantitative environmental impacts: Describe why it is important to assess the degree of human impact on the environment, not just the existence of an impact
18. Paleo and extraterrestrial perspectives on future climate change: Explain the advantages and disadvantages of studying the Earth's past and other planets to understand possible future climates for the Earth.
19. Biogeochemical cycling: Explain the importance of cycling through air, seawater, biota, and sediments.
20. Limitations on productivity: Identify specific nutrients and other factors which may limit photosynthesis. Predict where and when these factors may become limiting.
21. Growth and sustainability: Give examples of systems where exponential growth occurs. Explain what determines whether limited resources and exponential growth are compatible or incompatible.
22. Gaia hypothesis: Explain how some biological components of the Earth system affect the system to their own advantage and why this is more stable than the situation where biological components affect the system to their own disadvantage
23. Toxicity: Explain why the acceptable concentration for a particular chemical is difficult to define. Give an example of an element that is required at low concentrations but toxic at high concentrations.
24. Scientific approach and methods: Explain what makes a particular endeavor or approach scientific. Contrast science from mathematics, philosophy, religion, and politics. Describe benefits and worries in interactions between science and these other disciplines.

## 10 Other

- Clothing and behavior should be appropriate for a learning environment.
- Laptop and cellphone use should be appropriate for a learning environment—answering the phone; excessive texting, tweeting, emailing, playing games, shopping, facebooking, or worse! during class distracts other students and may result in immediate dismissal from class.
- There are politically-charged issue in this course. Discrimination and harassment will not be tolerated.
- Please contact me if you have any disabilities that require accommodation.

### 10.1 Lunchtime

We are meeting at lunchtime, and many of you may be booked with classes all day. It is OK with me if you bring food or drinks to class, so long as you are considerate. That is, no overly noisy, messy, or smelly foods.

And the CU boilerplate version, which I support:

**Special Accommodations** If you qualify for accommodations because of a disability, please submit to me a letter from Disability Services in a timely manner so that your needs be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and <http://www.colorado.edu/disabilityservices>

**Learning Disabilities** Disability Services' letters for students with disabilities indicate legally mandated reasonable accommodations. The syllabus statements and answers to Frequently Asked Questions can be found at <http://www.colorado.edu/disabilityservices>

**Religious Observance** Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, insert your procedures here See full details at <http://www.colorado.edu/policies/fac.relig.html>

**Class Behavior** Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at <http://www.colorado.edu/policies/classbehavior.html> and at [http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student\\_code](http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code)

**Discrimination & Harassment** The University of Colorado at Boulder policy on Discrimination and Harassment, the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships apply to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of discrimination or harassment based upon race, color, national origin, sex, age, disability, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH, the above referenced policies and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>

**Academic Integrity** All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council ([honor@colorado.edu](mailto:honor@colorado.edu); 303-725-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html> and at <http://www.colorado.edu/academics/honorcode>