

Syllabus for ATOC/GEOL3070: Introduction to Oceanography

Ocean View from 5430ft

Baylor Fox-Kemper

August 27, 2012

1 Contacts

- **Professor:** Baylor Fox-Kemper, bfk@colorado.edu, 303-492-0532
Office: Ekeley room S250B, <http://fox-kemper.com/teaching>
- **Teaching Assistant:** Chris Conrad, christopher.j.conrad@colorado.edu
- **Learning Assistants:** Evan Healey, evan.healey@colorado.edu, Neil Roberts neil.roberts@colorado.edu
- **Website:** <http://fox-kemper.com/3070>, username: IO, password: ocean
- **Office Hours:** Prof. Fox-Kemper's office hours are Tuesdays 11:30-12:30PM and Wednesdays 12:30-1:30PM in Ekeley S250B or by appointment (bfk@colorado.edu). TA Chris Conrad's office hours are Tuesdays and Thursdays 5-7PM in STAD 136C or by appointment (christopher.j.conrad@colorado.edu). Study center hours are Monday through Thursday 5-7PM in STAD 136C. Students are encouraged to seek homework help at these times.

2 Course Description

- Prerequisites: any two-course sequence of natural science core courses
- Approved for arts and sciences core curriculum: natural science (3 credits)
- Elective for ATOC minor elementary coursework

Investigates the broad-scale features and dynamics of the world oceans. The course is roughly divided amongst the four main disciplines of oceanography: marine geology, marine chemistry, physical oceanography (i.e., circulation), and marine biology. Students will learn that there is much overlap and interdependence between these disciplines. Specific topics include seafloor spreading, marine sediments, salinity, biogeochemical cycles, ocean structure, currents, waves, tides, primary production, marine ecology, global warming, and much more!

3 Meetings and Places

The course will meet in CHEM 140, 4-4:50PM on Mondays, Wednesdays, and Fridays. Prof. Fox-Kemper's office is nearby in Ekeley S250B. Office hours for Prof. Fox-Kemper and the TAs are listed above.

3.1 Friday Practica

Fridays will usually be special meetings when we will do collaborative practices or witness lab experiments. You will often only be required to attend 1/2 of the class time so that we can reduce the class size for collaborative groupings (Session A: 3:00-3:25, Session B: 3:30-3:55. We'll have a clicker signup during the first week). **Expect more clicker points** to be awarded during these Friday sessions!

3.2 Evening Study Center

For assistance with homework, exam prep, and questions, a study center will be available to you almost every Monday, Tuesday, Wednesday and Thursday evening 5-7. These study centers will occur in STAD 136C, through the door marked "ATOC Weather Lab". At these meetings, one TA and two LAs will be present. At least one of them will be specialized to this class and should be clear on homework assignments, etc. **Extra credit** of 2 points *to your final grade* will be granted for your first three visits for at least 30min. You may work on any class-related

activity with the TAs and LAs to earn this credit, but homework and exam prep are a good idea. However, TAs and LAs will not have the answers to homework or have seen the exam questions—they are to work with you not to give you the answers. You *must sign in with the TA in legible handwriting* to earn the credit.

4 Goals

In this class you will attend 3 hours of lecture and related to the ocean. You will also:

- Meet other ocean-interested students
- Learn about geological, chemical, physical and biological processes that occur in the ocean, their observation, and their quantification
- Learn about the ocean's role in climate and what we understand about oceanic climate change
- Learn how scientific methods and thinking are applied
- Become “Ocean Literate”: you will have the knowledge and skills to comprehend discussions on the oceans from sources such as the New York Times science page and DotEarth blog, the IPCC report summaries, the RealClimate blog, and Scientific American.

5 Grading

Grading: 40% homework, 25% final exam, 15% midterm exam, 20% clicker questions, up to 6% extra credit for Study Center attendance. Letter grades for final exam will be based on a 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 <http://learn.colorado.edu>. 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, and *all absences must be confirmed by an email exchange to and from the Professor*. 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 first Friday practice class. The first homework will 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.

6.2 Disruptive Behavior: Laptops, Tablets, Cellphones, Clothing, and Weapons

- Clothing and behavior should be appropriate for a learning environment.
- There are politically-charged issue in this course. Discrimination and harassment will not be tolerated.

Laptop and cellphone use should be appropriate for a learning environment—answering the phone; excessive texting, tweeting, emailing, playing games, shopping, or worse! during class distracts other students and may result in immediate dismissal from class. **Anyone planning to use a laptop or tablet throughout class must sit on the outer or back row of occupied seats, so no one behind them is distracted.**

Students with appropriate permits are allowed to bring concealed weapons throughout the CU campus, including classrooms. However, the inappropriate *use* of weapons, like the use of any item brought to class, is subject to the rules of course-related behavior. For example, overt display or brandishing of a weapon during a debate is inappropriate behavior and will lead to immediate exclusion from the instructor’s classroom or academic area, pending expedited review by Judicial Affairs in accordance with the rules of course-related behavior (<http://www.colorado.edu/policies/student-classroom-and-course-related-behavior>). The CU Board of Regents policy prevents the open display of weapons, including guns, explosives and knives on campus. Only law enforcement officials who display their badges are allowed to openly display weapons while on campus. Under concealed carry, anyone with a permit may carry a concealed handgun on campus generally and into CU buildings, with the exception of Folsom Field and any other ticketed public performance venue.

Any clicker questions or other assignments missed during dismissal for disruptive behavior may be subject to academic sanction (i.e., no make-up points), as course participation is a component of the final grade and is indicated in the course syllabus. This document will be considered a warning given by the instructor, and no further warning is required before dismissal from any academic area.

7 Textbooks and Reading

The official textbook for the class is Tom Garrison’s *Oceanography: An Invitation to Marine Science*. A few chapters and pamphlets outside of Garrison are required reading as well, as indicated on the webpage. The additional online resources for the book are not required, but they may be good study tools. Additional reading materials are to be found on the webpage.

Each reading assignment goes along with the lectures that week as well as a Desire2Learn 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 are needed for you to get the most out of the course. 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/AT0C3070_12/notes/readingprimer.pdf

8 Assignments and Exams

8.1 Weekly Homework on Desire2Learn

About once a week a homework assignment is due on Desire2Learn (<http://learn.colorado.edu>). A calendar of due dates is on the website and Desire2Learn. As a registered student, you should be able to log into Desire2Learn with your normal CU identikey.

You may use your textbook, notes, the web materials, etc., to answer the questions on learn.colorado.edu. You may also discuss the chapters and homework questions with your study partners. However, you are bound by the CU honor code that you answer the learn.colorado.edu 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 homework 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 assessments should be posted two weeks before they are due. When you are sure you are done with the homework, click ‘Finish’ and make sure you get the ‘Submitted’ confirmation. Late homework will not be accepted.

You will also see some running grade averages in Desire2Learn. 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. All exam scores will only be curved before posting.

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 ocean, 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. As this course has a two-semester science sequence as a prerequisite, some math and equation manipulation will be required for some questions, and knowledge of 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+0) if there is no correct answer or you are being encouraged to guess. Clicker questions may be worth more points.

The dropped 15% of 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 for credit on the first Friday.

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. Recently 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 (Monday, October 29, 4pm–5pm). 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 (Wednesday, December 19, 2012, 7:30am–10:00am). 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. The final will cover material from the entire semester.

Both exams will be closed book, but you may bring 1, 2-sided (front & back filled), letter-paper-sized study sheet. You should make your own sheet or collaborate with a friend or make it at the Study Center—it's a really good way to learn! You are not required to turn in the study sheet after the exam. You will not need a calculator.

9 Critical Concepts

Oceanography 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 oceans. 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 oceanography will be new. You will find that many of the concepts are applicable to multiple aspects of oceanography, and will appear repeatedly during the course. These concepts would be conveyed by any professor teaching this class.

1. Electromagnetic spectrum: Describe the fate of electromagnetic radiation as it enters the ocean or atmosphere or hits clouds or land. Relate these fate to the Greenhouse effect, and how the climate system modulates the temperature of the earth. Explain how different colors/wavelengths of light behave differently.
2. 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.
3. Isostatic equilibrium: Explain how isostatic equilibrium accounts for variations in surface topography with crustal density and thickness, the existence of ocean basins, and the buoyancy of icebergs and ships.
4. Convection: Describe the conditions necessary for the development of a convection cell. Identify the driving forces behind convection of the mantle, ocean, and atmosphere.
5. Particle transport: Explain what variables control the settling rate of a spherical particle according to Stokes Law. Describe the sediment sizes and modes of transportation for terrigenous particles reaching the deep sea.
6. Tracer transport and 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 ocean. Explain how tracers indicate water masses and processes in the ocean.
7. 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.
8. Seawater density: Predict how the density of seawater would change with temperature, salinity, and pressure. Contrast the influence of temperature on pure vs. salty water. Compare the relative influence of salinity in warm vs. cold seawater.
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. Use the latitudinal variation of Coriolis to explain why western boundary currents are more intense than eastern boundary currents.
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. Thermohaline flow: Explain why (and what) energy is ultimately required to drive the thermohaline circulation, and under what surface conditions deep waters may form.
13. Deep vs. shallow water gravity waves: Distinguish between deep water and shallow water waves on the basis of wavelength and water depth. Name the variable that the velocity of each wave type depends on.
14. Waves and Currents: Explain what a wave is. Explain what a current is. How do they differ in time? In transport of water? In transport of sediments and tracers?
15. Tide generating force: Predict how the gravitational attraction between two objects varies with mass and distance. Sketch the lunar and solar contributions to Earth's tidal bulges for different phases of the moon.
16. 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.
17. Biogeochemical cycling: Describe the role of electron transfer in photosynthesis and respiration. Explain the importance of nutrient cycling through seawater, biota, and sediments.

18. Limitations on productivity: Identify specific nutrients and other factors which may limit marine photosynthesis. Predict where and when these factors may become limiting.
19. Food chain efficiency: Explain why mass transfer across increasing trophic levels is inefficient. Calculate the percent biomass transferred from algae to a given trophic level.
20. Maximum sustainable yield: Summarize the basic population dynamics that allow for a healthy fishery. Explain why harvesting older fish has both benefits and risks.
21. 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.
22. Chemosynthesis: Compare and contrast between photosynthesis and chemosynthesis. Explain how energy may be extracted from certain inorganic compounds, and give an example.

9.1 Disabilities

Please contact me if you have any disabilities that require accommodation.

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>

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; 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>