

Syllabus for ATOC/GEOL3070: Introduction to Oceanography

Or, Lunch by the Sea

Baylor Fox-Kemper

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1 Contacts

The professor for this class is:

Baylor Fox-Kemper, bfk@colorado.edu, 303-492-0532, Office: Ekeley S250B

The website is: http://cires.colorado.edu/science/groups/foxkemper/classes/ATOC3070_09

Office Hours are: Wednesday and Thursday, 2-3PM or by appointment at Ekeley S250B.

2 Course Description

Prerequisites: any two-course sequence of natural science core courses

Approved for arts and sciences core curriculum: natural science (3 credits)

Investigates the broad-scale features and dynamics of the Earth's 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 Hellems 201, 12-12:50PM on Mondays, Wednesdays, and Fridays. Prof. Fox-Kemper's office is nearby in Ekeley S250B where office hours will be held Wednesdays and Thursdays 2-3PM or by appointment.

3.1 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.

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

5 Grading

Grading: 50% homework, 30% final exam, 20% clicker questions. Letter grades for final exam will be based on a class-wide curves. Homeworks and clicker questions will not be curved, but your two lowest homework assignment grades will be dropped.

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. Grades from the 5 lowest clicker days and 2 lowest homework assignments will be dropped, which will 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. The final exam may not be dropped or excused.

7 Textbooks and Reading

The official textbook for the class is Tom Garrison's *Oceanography: An Invitation to Marine Science*. 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. A few chapters and pamphlets outside of Garrison are required reading as well, as indicated 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 read a chapter in the following order: 'Chapter at a Glance', chapter introduction, flip through the chapter reading the section headings and figures, 'Chapter in Perspective', 'Key Concepts Review', and only then read from front to back. 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.

8 Assignments and Exams

8.1 Weekly Homework on CULearn

About once a week 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. You may begin an assignment and save your progress without completing it. You may submit an assignment early if you expect that other classwork, etc. will interfere near the due date. Late homework will not be accepted without advance permission.

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. 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>, 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 two points for answering the question, plus (usually) one additional point for a correct answer. Your five lowest clicker scores (i.e., from five class days) will be dropped from your final clicker score. This five class credit is 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*. Clicker questions will start in lecture on Wednesday 8/26 and will begin counting toward your grade on Monday 8/31.

8.3 Final Exam

A final exam will be given at the scheduled time (Wed. Dec. 16, 4:30-7:00PM). For the vast majority of cases, the final exam cannot be rescheduled. A missed exam will reduce your final grade to a D or lower. The final exam questions will be similar to—but generally quicker to answer than—the homework assignment questions, and will cover all of the semester.

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.

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 or emailing, playing games, shopping, or facebooking during class distracts other students and any will result in immediate dismissal from class.
- Discrimination and harassment will not be tolerated.
- 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>