Syllabus for ATOC 5061: Models of Oceans

1   Contacts

The professor for this class is: Baylor Fox-Kemper
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http://cires.colorado.edu/science/groups/foxkemper/classes

2   Goals

In this class you will:

- Learn about many of the physical processes that occur in the ocean.
- Learn about some of the simple models used to understand these processes.
- Learn about some of the dominant balances that describe these processes.
- Learn to solve many of these models numerically and analytically.
- Learn some tools and approaches for analyzing these models, and discuss how these approaches might apply to more realistic models and observations.

3   Meetings and Places

We will meet Tuesdays and Thursdays from 1 to 2:15 in Ekeley W240 (CSES Computer Lab). Office hours will be by appointment at my office (Ekeley S250B). You can check my availability here: http://cires.colorado.edu/science/groups/foxkemper/contact. I have a group meeting 2:15-3:15 Tuesday with my students that you can hang around for if you like.

The student computer lab upstairs in the stadium and Ekeley W240 should have the software we'll be using (matlab and other stuff from my webpage) loaded. I'll get a door access code to the South door of W240 for everybody, shortly. For the computers, your username is first inital and last name (Barack Obama-¿bobama) and temporary password is Class2009. The W240 room is right around the corner from my office, so you can find me if there are problems. All RAs are entitled to a free matlab license for their work machines–I can help with that, too.

4   CULearn and Websites

The primary resource for this class is http://cires.colorado.edu/science/groups/foxkemper/classes/ATOC5061_09. The class webpage is where all of your assignments will be announced, links to reading, notes, and models will be posted, etc.

The second web resource are the CULearn pages for the class. If you are registered for the class, you should be able to access them from http://culearn.colorado.edu. I will be using this page for some secure communications. For example, all of your grades will be available there, the weekly assignments will be connected through there, and you can post/read discussions about homework, etc.

CULearn is occasionally inadequate for some assignments. If you are ever in doubt, just send me the content in an email.

5   Textbooks and Software

The official textbook for the class is, 'Atmospheric and Oceanic Fluid Dynamics', by G. K. Vallis. There will also be chapters in other books and research papers linked through the webpage, and those may be password-protected. The username is atoc5061_09 and the password is Mod3lOshun.

All of the required readings will be posted on the website. Hard copies of many of these books are available from the library or you can borrow my copies if you prefer. Also, my notes on each model will be posted there (see below for more comments).

6   Assignments and Exams

I plan for weekly assignments for this class, which will be mostly through CULearn. The concept is that we will discuss a topic or method in lecture, fiddle around with the models toward the end of class, and then you will follow up at home by doing reading and some calculations with the model. As is typical of my limited facilities on CULearn–some questions will not work or will be broken. You will not be penalized for this, but it helps me if you point this out in class! The assignments will be due on Monday night at 7PM, so I have a chance to look over the results before class on Tuesday.

I plan for a take-home midterm and final, and these will be essentially a slightly larger version of the weekly assignments that will attempt a synthesis of the preceding ideas and techniques.

The division of importance for grading will be:

- 5% per homework assignment (13 *5%=65% for all assignments)
- 10% midterm
- 15% final
- 10% help me out!

So, the midterm counts as two homeworks and the final counts for three. The final 10% will be for helping out with the notes, as mentioned below.

6.1   Why models?

Traditionally, ocean dynamics is taught as a lecture course where rotating, stratified Navier-Stokes is analyzed over and over under different dominant balances. Much of the class takes place in the quasi-geostrophic framework or the planetary geostrophic framework, and often the example problems are either too trivial (e.g., plane Rossby waves) or too hard (e.g., the Charney instability) to get much of a handle on the underlying physical concepts on the first pass. Furthermore, the equations that are worked out often have huge missing elements (e.g., boundary conditions or forcing!) that make the discussion unsatisfyingly incomplete. So, I found as I learned this material that I had to do a lot of work if I wanted to actually *solve* a set of equations instead of just discussing them.

Instead, the idea here will be to work from solvable or solved models, which sometimes have a rigorous derivation and sometimes are pulled out of thin air. We will be sure to always have all the ingredients for a full solution, and then we will study the behaviors of these solutions. The trick will be to try to get at the physical concepts exemplified by each model, not just the equation manipulation to derive pieces of the equation set.

As such, we will not spend much time on rigorous derivations of traditional approximations, e.g., quasigeostrophy. I will try, however, to briefly summarize the gist and point you to nice derivations in Vallis, Pedlosky, Cushman-Roisin and Beckers, Gill, etc. as we go along.

We will be using matlab a lot to do problems that we can't solve by hand, but we'll also do some equation manipulation by hand.

6.2 Help Me Out with the Notes and Models

If all goes well, I would like to work up the notes from this class into a textbook since I like this approach to learning. Even if not, I'll probably teach this class again working from the same set of notes. So, I've left a small portion of your grade for you helping me out with the improvement of the notes and numerical models. What I mean by that is, when you are reading through the notes or when you are using one of the matlab codes, I'd like feedback on what works and doesn't. I anticipate that you'd probably do this anyway (and I anticipate that you will all have little trouble earning that 10% of your grade), but I want to make my request for feedback official.

I appreciate any comments–positive, negative, critical, suggesting new sections or suggesting removal of sections. Even just comments like 'I have no idea what you mean by this word/sentence/paragraph/chapter' are great. It is all useful to me and will improve the class and notes.

I would particularly appreciate code in the models or code commentary in the numerical models. It is extremely hard for me to figure out which pieces of code are obvious and which are obfuscating. Once you figure out a difficult piece of coding out, writing a description comment that makes sense to you and passing it on to me would really help!

As we go along, I will be posting the notes and models as soon as I have a working draft available. I'll keep changing them, fixing bugs and typos, and adding pieces as the class progresses. So, If you want to keep a set, I would encourage you not to print them out as soon as they appear, but wait a while after we talk about each section in class.

If anything ever comes of this, your contributions will be acknowledged.

7 Policies

I will put a clock on the homework assignments on CULearn, so they should be turned in on time (likewise for exams). That way, I can plan to comment on the questions in the next class session without having some folks still working on problem sets.

I encourage you to work together on the homeworks, and I do not mind at all if you share figures or matlab scripts. However, you are all required to submit a version of each assignment as first author (that is, one that you wrote yourself). When you fill out the CULearn assignments, you are on your honor to be the one answering the questions not just asking your officemate who is already done.

A few other items.

- Assignment deadlines are firm, extension requests need to be made before the deadline, not after.
- Attendance is expected. If you will miss a class, please let me know when and why so I can be sure you'll get any announcements, etc. I have experimented in the past with video-conferencing with some success for predicable absences.
- Clothing and behavior (e.g., cell phone use) should be appropriate for a learning environment.
- 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:

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 www.Colorado.EDU/disabilityservices

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 www.colorado.edu/disabilityservices

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

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

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

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/