

# Syllabus for ATOC 5051: Introduction to Physical Oceanography or, Notions for the Motions of the Oceans

## 1 Contacts

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[http://cires.colorado.edu/science/groups/foxkemper/classes/ATOC5051\\_10](http://cires.colorado.edu/science/groups/foxkemper/classes/ATOC5051_10) or

<http://tinyurl.com/yg7bnrh>

## 2 Goals

In this class you will:

- Learn about many of the physical processes that occur in the ocean.
- Learn about how these physical processes are observed and quantified.
- Learn about where these processes occur in the ocean.
- Learn about and access recent ocean datasets.
- Get practice writing and thinking scientifically by focused study on particular processes.
- You will also get a broader perspective and more practice by peer reviewing your colleagues' efforts.

A list of the basic topics covered in this class is:

- Observations
  - What instruments are common to oceanography?
  - How are these measurements used?
  - How do the types of measurements influence the theoretical developments?
- Fluids Mechanics
  - The differential equations describing a fluid
  - The differential equations describing a Boussinesq fluid
  - How the differential equations relate to budgets
- Rotation
  - The equations for fluid motion in a rotating frame of reference
  - Ekman boundary layers
  - Geostrophic balance
- Stratification
  - The temperature, salinity, and density stratification of the ocean
  - Hydrostasy
  - Baroclinic and Barotropic
  - Potential temperature and potential density
  - Thermal wind balance
- Vorticity
  - Taylor-Proudman Flow
  - Sverdrup Flow

- Ocean Circulation
  - The Wind-Driven Ocean Circulation
  - Simple Western Boundary Currents–Stommel & Munk
  - The Meridional Overturning Circulation
  - Theories of the Thermocline
- Wave Basics
  - Dispersive Wave Kinematics: Phase & Group velocity
  - Kinds of ocean waves: surface gravity, internal gravity, Rossby, Kelvin

These topics can be located in many textbooks (Vallis, 2006; Cushman-Roisin and Beckers, 2010; Tomczak and Godfrey, 1994; Stewart, 2008). Particular emphasis in this course is on Vallis (2006) chapters 1-4 and 14-16 and on the non-numerical sections of Cushman-Roisin and Beckers (2010) (Chapters 1-6, 7-9, 11-13, 15, 20, 21, and Appendices A & B).

### 3 Meetings and Places

We will meet Tuesdays and Thursdays from 2 to 3:15 in Duane G131. Office hours will be 3:30 to 5 Tuesdays and most Thursdays at my office (Ekeley S250B). I have a group meeting 3-4 Fridays with my students that you can drop in on if you are considering ocean-focused research. I am also available by appointment other times and you can check my schedule here: <http://tinyurl.com/yz56xnh>.

The student computer lab upstairs in the stadium and a computer room in Ekeley W240 should have the software we'll be using (matlab, idl, and opendap) loaded. The W240 room is right around the corner from my office, so you can find me if there are problems. We will discuss in class whether you need access to this room, if so I will arrange it.

### 4 CULearn and Websites

The primary resource for this class is the webpage: <http://tinyurl.com/yg7bnrh>. The class webpage is where all of your assignments will be announced, links to reading 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 CULearn for some secure communications. For example, all of your grades will be available there, the reading quizzes will be connected through there, and you can post/read discussions about homeworks, etc.

You will want to familiarize yourself with Google Scholar (<http://scholar.google.com>) and the Web of Science (<http://apps.isiknowledge.com>). Both are free to you, and they will help you with your paper preparations.

### 5 Textbooks and Software

The primary textbooks for the class are, *Atmospheric and Oceanic Fluid Dynamics*, by G. K. Vallis and Cushman-Roisin and Beckers's *Introduction to Geophysical Fluid Dynamics*. There are also a few online textbooks linked through the webpage (Stewart, Tomczak & Godfrey), as well as a few chapters and readings that are password-protected. The password has been emailed to you.

All of the required readings will be posted on the website. Hard copies of many of these books, as well as some others you should become familiar with will be on reserve in the Math/Physics library just down the hall from our classroom. I recommend browsing a bit and seeing what there is.

We will have short 'reading quizzes' through CULearn. I will schedule them so that they will indicate when you should have completed a reading assignment. They are quick ( $\approx 10$  multiple-choice questions) and are not intended to be hard if you read the assignment. They are intended to draw your attention

to the most important bits of reading, and they are open book. These questions are good COMPS study guide questions.

The class will require use of software capable of opening ocean datasets. I strongly recommend matlab, but you could use IDL, Ocean Data View, or ferret (although I will be less able to offer help!). All of these are available to you free for PC, Mac, and Linux. I will take a survey during the first class and get disks for you, etc. by the second class.

## 6 Assignments and (lack of) Exams

There will be five major assignments for this class, and all of them will be in the form of short scientific reports. You will be working on two assignments at a time, reviewing and revising the last one (a little work), and preparing the next one (more work). There will also be short online reading quizzes through CULearn. There will be no additional exams or midterms. The final revision of the final paper is presently scheduled to be turned in at the end of exam week, although I have tried to schedule sufficient time the preceding week so that it can be completed before exams. The weighting of the assignments will be:

- 10% Plans for papers.
- 40% Original submission of papers.
- 20% Revised submission of papers.
- 20% Reviews of other students' papers.
- 10% Reading quizzes.

What can I do to get a good grade? First, I think it should be made clear that the relative importance of learning to grades is substantially more skewed in graduate school than for undergraduates. Graduate students' grades are generally not heavily analyzed, and getting all As in graduate school almost certainly means you're wasting your time.<sup>1</sup> Future jobs will depend on the quality of your research and teaching, which depend on what you learned not what grade you got. That said, the totally free-form assignments in this class have proven intimidating to some students. Thus, note that the reading quizzes, reviews, and revised submission of papers are highly guided in what you can do to improve your grade.

Assignments are to be in pdf file format and created according to American Geophysical Union Geophysical Research Letters templates. If you want to use LaTeX, the software is already loaded in the learning lab and I can help. If you want to use something else, you can download the AGU templates, but you're on your own if things go wrong!

The scheduling of the assignments are listed on the webpage, and other than the exceptional week around fall break will be as follows.

- Paper assignment  $\#n$  will be due on a Friday at 5 PM. They will be submitted electronically.
- By Monday at noon, you will receive two of your colleagues'  $\#n$  papers to review electronically. Who is reviewing whom will be anonymous.
- On Tuesday, we will have class and office hours. You can discuss anything with me or the class about your paper or the papers you are reviewing ( $\#n$ ) or paper  $\#n+1$  that *you have already begun thinking about*. Be careful to preserve your reviewer anonymity!
- On Wednesday by 5 PM, your reviews of your colleagues' two papers ( $\#n$ ) are done and submitted electronically to me.
- By Thursday midnight, I will have your paper  $\#n$  back to you, with my reviews and your peer reviews. Discussion during office hours is encouraged of returned paper  $\#n$
- The following Wednesday at 5 PM, a revised version of your paper is due.

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<sup>1</sup>Important exceptions are fellowships—which sometimes require a minimum GPA—and preliminary or qualifying examination review of coursework (In this case, the difference between an A+ and an A is nil).

- That Friday, a summary of what you plan to do on paper  $\#n + 1$  is due. I encourage you to have generated some results and looked for some references. I will respond by email with suggestions for the following week.
- The following Friday, paper  $\#n + 1$  is due, and the process restarts.

All of this will be charted out on the calendar on the website and in CULearn.

Before you get worried about writing five papers for one class, let me explain the goals of the paper writing. These are *not* supposed to be polished, ready to submit papers detailing years of research. Instead, they are supposed to be practice in writing drafts for your real research. The idea is to get used to pounding out a working draft in only a couple of hours, so that when the time comes for you to do it for real, that part will be easy.

Since you all have different preparation, you will all be able to take advantage of what you know. However, we are working to develop elements in all of the following:

- Quantitative Skills and Equations for the Ocean (Theory/Modeling Component)
- Descriptive Skills and Geography of Ocean Currents (Descriptive Oceanography)
- Understanding of Ocean Observations and Techniques (Observations/Engineering Component)
- Physical Intuition and Dynamical Understanding (Theory/Dynamics Component)
- Implications for Climate, Society, etc. (Policy & Climate Component)

By the end of the semester, you should have addressed each element somewhat in some of your papers.

I hope you will get inspired along the way, and you can revise one of these little papers into a real paper or a comps project, but don't get upset because you have to hit the ground running. You'll have to do it sometime, and this will be in a friendly environment!

## 6.1 Why papers?

I think that this approach helps to balance the class. Folks with a lot of quantitative experience will be able to use that to their advantage while folks with more substantial preparation in writing, argument, and logical structure will be able to use those abilities. We will be using the most up-to-date oceanographic datasets available, and so the work you are doing is potentially cutting edge research (but that's up to you!). Also, in the future you will be expected to write much more complicated papers in a more tightly constrained time frame, you might as well get some practice now.

## 6.2 Peer review

In addition to writing the papers, you will each be performing anonymous reviews of each others work. This will give you an opportunity to read closely about topics other than the one you chose, and hopefully you will be able to learn about science writing more quickly. Also, there are a lot of quandaries that arise in peer-reviewing (e.g., one reviewer loves it and one hates it, or a reviewer makes incorrect statements), so you'll get some experience with those issues by practice in a friendly environment.

We will be using a rubric based on the AGU guidelines for review. They are a useful guideline to go by, and when you do reviews of your fellow students, I'll expect to get a A1 or B2 or B1 score, etc.

There are a few lessons to be learned here, that will help you write your own papers and will help you provide effective and useful reviews in your career.

- Learning to spot unfounded claims
- Learning how to properly support claims
- Learning to distinguish poor writing from poor thinking
- Learning to label equations, graphs, and numerical information understandably
- Learning about a broader swath of oceanography than those isolated topics you choose for your own papers.

## 6.3 What will we do with all these peer-reviewed papers?

As the semester continues, there will be some papers of yours that you like quite a bit, or that were very positively reviewed. Either you or me can designate them as 'publishable', so that the whole class can see them and subsequent classes can, too. At the end of the semester, all of you will be able to access the assembled published papers: 'Proceedings of ATOC 5051: Notions for the Motions of the Oceans, Spring 2010'. You can use this proceedings for your future reference, and it will be available for future ATOC 5051 inductees. It is up to you which papers you want published (if any).

You can access the previous year's proceedings through the course website with the password I've emailed to you. You will find many good ideas and interesting papers there to help you find your way in writing your own.

## 7 Policies

### 7.1 Deadlines

Because of the reviewing process, the scheduling of assignments is tight. Thus, I will have to insist that all papers be turned in on time. If they are late, they will drop a letter grade. If they are really late (so that they mess up the next step in the reviewing process) they will be counted as missed and can not be made up. If you foresee that there are big problems coming up (medical, family, etc.) let me know *before* an assignment is due and we can figure something out.

### 7.2 Collaboration

I encourage you to work together, and I do not mind at all if you have similar papers or share figures or matlab scripts. However, in this case, I want you to list all of your study group as co-authors or put them in the acknowledgments section of your paper. You are all required to submit a version of each assignment as first author (that is, one that you wrote yourself). You need to be careful to cite your colleagues or the textbooks or papers you might be working from. You can use as much of these resources as is convenient in your version of the paper, but you need to properly cite the sources. We will discuss this topic more as the class (and the inevitable trouble) ensues. These issues of plagiarism and proper sourcing are a big part of what is to be learned in this method of assignments.

A few other items.

- 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.
- 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:

**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](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>

**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>.

## References

- Cushman-Roisin, B. and J. M. Beckers, 2010: *Introduction to geophysical fluid dynamics: Physical and Numerical Aspects*. Academic Press.
- Stewart, R. H., 2008: *Introduction to Physical Oceanography*. R. H. Stewart (online website self-publication), URL [http://oceanworld.tamu.edu/ocean410/ocng410\\_text\\_book.html](http://oceanworld.tamu.edu/ocean410/ocng410_text_book.html).
- Tomczak, M. and J. S. Godfrey, 1994: *Regional oceanography: an introduction*. 1st ed., Pergamon, Oxford, England, URL <http://gyre.umeoce.maine.edu/physicalocean/Tomczak/regoc/pdfversion.html>.
- Vallis, G. K., 2006: *Atmospheric and Oceanic Fluid Dynamics : Fundamentals and Large-Scale Circulation*. Cambridge University Press, Cambridge.