270.626 Ocean General Circulation

Fall Term 2017.

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Tuesdays & Thursdays 8:30–10:30am, Olin 346

Synopsis

This course is on the low-frequency global ocean general circulation. The treatment is mainly phenomenological, but intuitive physical explanations are attempted almost everywhere, and there are some more detailed mathematical models too. The course is designed for graduate students with interests in oceans, atmospheres, climate dynamics, geophysics, and/or fluids. Basic familiarity with fluid mechanics is required, and a solid grounding in physics, and mathematical methods for physics, at undergraduate level is assumed. The course may be accessible to you without these requirements, but expect to do some remedial work to catch up. Prior exposure to physical oceanography (or atmospheric dynamics) is an advantage, but is not required. Again, expect to do some background reading if necessary.

Format: The course will be taught as 80min classes twice a week. Some classes must be re-scheduled as I'm traveling. There will be a few lecture presentations and some traditional note-taking as I lecture. More importantly, there will often be chance to discuss ideas and work on problems together during class. We will sometimes use matlab software to make computations and display data. Let me know if you don't have access to matlab, or have never used it before. There will also be student discussion of homework. Class materials will be posted to Blackboard (Bb). I expect you to review materials (presentation pdfs, textbook reading) beforehand, so that during class we can focus on problems. Office hours are by arrangement.

Any student with a disability who may need accommodations in this class must obtain an accommodation letter from Student Disability Services, 385 Garland, (410) 516-4720, studentdisabilityservices@jhu.edu.

I'm excited to teach Ocean General Circulation! This subject is fascinating!

Topics

We will pick a subset (probably topics 1, 2 plus 3 others) of the following topics:

1. Physical Oceanography: Methods and Dynamical Framework
2. Rotating and Shallow-Water Flow

3. Two-Dimensional Horizontal Circulation
4. Surface and Mixed Layer Properties
5. Gyre-Scale Structures and Depth-Dependent Geostrophic Circulation
6. Ekman Transport, Shallow Overturning Cells, and Upwelling Regions
7. Eddies and Small Scale Mixing
8. Deep Meridional Overturning
9. The Southern Ocean Nexus
10. Arctic Circulation
11. Heat Flux, Freshwater Flux, and Climate

Textbooks

The course is based on a textbook in preparation (*Klinger and Haine* to appear in 2018; `http://mason.gmu.edu/~bklinger/bookhome.html`). The topics above are the chapters in this book, and you will help the development of the textbook by participating in the class! The following are also good for reference, at least on the more theoretical aspects:

- Basic principles: *Marshall and Plumb* (2008); *Cushman-Roisin* (1994). (A new edition of Cushman-Roisin's book was published in 2011, and is much updated.)
- At the level of the class: *Vallis* (2006) (although we only cover a fraction of this material).
- Advanced reading: *Pedlosky* (1996); *Salmon* (1998).

Also check out Bob Stewart's online book at:
`http://oceanworld.tamu.edu/home/course_book.htm` which covers the phenomenology and observations of the global ocean circulation well at the level of a senior undergraduate class.

Assessment

The final grade in this class will depend on the following input data:

1. Class participation, including informal discussion, and presenting material,
2. Homeworks (probably 7 in total).

There will be no final exam. Attendance at each class is expected, and is essential for good performance. Please inform me ahead of time if you cannot attend class, or as soon as is practicable. You will not be academically penalized for following the advice of health professionals! Similarly, religious holidays are valid reasons to be excused from class, but please inform me in advance.

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

The specific ethics guidelines for this course are: *Homework assignments must be completed without any collaboration with anyone else. I encourage you to discuss homework problems with other students, but you must write up your own answers unless told otherwise. All printed and online information source should be accurately cited. There may also be some assignments where you work together.*

Report any violations you witness to the instructor. Please see the website `http://web.jhu.edu/studentlife/policies/judicial.html` for more information.

References

Cushman-Roisin, B. (1994), *Introduction to geophysical fluid dynamics*, Prentice-Hall, Inc., Englewood Cliffs, NJ, USA.

Klinger, B. A., and T. W. N. Haine (to appear in 2018), *Ocean Circulation in Three Dimensions*, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Marshall, J., and R. A. Plumb (2008), *Atmosphere, Ocean, and Climate Dynamics: An Introductory Text*, 319 pp. pp., Elsevier Inc.

Pedlosky, J. (1996), *Ocean circulation theory*, Springer-Verlag.

Salmon, R. (1998), *Lectures on geophysical fluid dynamics*, Oxford University Press.

Vallis, G. K. (2006), *Atmospheric and Oceanic Fluid Dynamics: Fundamentals and Large-scale Circulation*, 1st ed., 745 pp., Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.