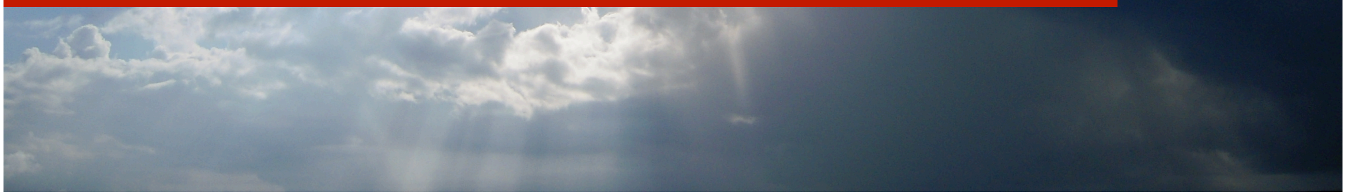
Fall 2012

Geophysical Fluid Dynamics



Tuesdays, 9:00 am - 10:50 am, Warren Weaver Hall 517

Instructor

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Course Description

Our goal is to understand the equations that govern the flow of the atmosphere and oceans. The answer, my friend, is blowin' in the wind, but it will become more clear once we introduce approximations to the Navier-Stokes equations of fluid flow appropriate to geophysical scale flows. Two key themes that will recur throughout the class are rotation and stratification. The spinning of the Earth, and the variation of radiation with latitude, create a playground for a number of waves and instabilities, driving both the weather over our heads and the undulations of the oceans.

Class Expectations

I look forward to seeing you in all the lectures. If you can't make it, please e-mail me in advance if possible. Please do the homework; it will solidify the lectures. Work together; you'll learn more as a group. And finally, ask questions, both of me and your fellow classmates.

Your grade will be based on a final exam. A second goal of the final exam is to provide a warm up for the students preparing for the GFD written exam.

Textbook

Geoffrey K. Vallis, 2006, *Atmospheric and Oceanic Fluid Dynamics: Fundamentals and Large-Scale Circulation*, Cambridge University Press, 745 pp.

Additional Resources

Cushmin-Roisin, Benoit, 1994: *Introduction to Geophysical Fluid Dynamics*, Prentice Hall, 320 pp. [Alas, I'm afraid that this nice introductory text (yet written at a level appropriate for graduate students) in no longer in print.]

Gill, Adrian, 1982: *Atmosphere-Ocean Dynamics*, Academic Press, 662 pp. [Gill takes a different track that Vallis, providing an alternate perspective.]

Pedlosky, Joseph, 1987: *Geophysical Fluid Dynamics (Second Edition)*, Springer-Verlag, 710 pp. [This veritable "old testament" of the field presents a more mathematically rigorous approach to GFD than Vallis.]

Salmon, Rick, 1998: *Lectures on Geophysical Fluid Dynamics*. Oxford University Press, 378 pp. [This is another nice text on GFD, providing an alternative narrative to the Vallis text, but with more physical insights than in Pedlosky.]

Walker, Gabrielle, 2007: *An Ocean of Air,* Houghton Mifflin Harcourt, 288 pp. [This popular science text is a fun read, well, at least if you're an AOS geek like me, and a nice introduction to the history of the field. Good for cocktail party conversation, well, assuming that other AOS geeks are attending the party. Who let them in?]

Course Plan

Our aim is to cover much of the first 6 chapters of the Vallis text, plus topics form chapters 7-9 as time permits. This is an ambitious plan, and I won't be able to cover all the details in class. Hence I'll expect you to be filling in details by reading the text and completing the homework assignments.

1. Introduction + Motivation
2. Fluid dynamics fundamentals: the Eulerian and Lagrangian perspectives
3. Fluid dynamics continued + Introduction to stratification
4. The equation of state, entropy, stratification, sound, buoyancy frequency
5. Inertia gravity waves, introduction to rotation, and working on the sphere
6. Geophysical Fluid Dynamics: They key approximations
7. The Shallow Water Equations
8. Energy Conservation + Wave Basics
9. Geostrophic Adjustment and Balance + the Quasi-Geostrophic Equations
10. Rossby Waves
11. Barotropic Instabilities + "Stirring" and Jets
12. The two layer equations + Continuous stratification
13. Baroclinic Instability
14. Turbulence Basics