SIOC 212A (Winter 2024)

Geophysical Fluid Dynamics I

Instructor: Ian Eisenman, (office) Nierenberg Hall 223, (email) eisenman@ucsd.edu.

Course website: Canvas.

Lecture schedule ***(evolving)***

- Mon 1/08 (01): Basic equations [relevant textbook sections: Vallis (V) chapter 1, Cushman-Roisin & Beckers (C) chapters 1 & 3]
- Wed 1/10 (02): Rotating coordinate system (V 2.1, C 2.1)
- Mon 1/15: *No class (Martin Luther King Jr. Day)*
- Wed 1/17: *No class (instructor on travel)*
- Mon 1/22 (03): Geoid, Coriolis force (V 2.2-2.3, C 2.2 & 2.4-2.5)
- Wed 1/24 (04): Inertial oscillations (C 2.3)
- **Fri** 1/06 (05) *(make-up class)*: Momentum equation scaling, hydrostatic approximation (V 2.7, C 4.3)
- Mon 1/29 (06): Shallow water equations (V 3.1, C 7.1-7.3)
- Wed 1/31 (07): Geostrophic adjustment (V 3.9, C 15.2)
- Mon 2/05 (08): Potential vorticity (V 3.7.1, C 7.4)
- Wed 2/07 (09): Scaling and balances in shallow water equations
- Mon 2/12 (10): Boussinesq approximation, stratification, thermal wind (V 2.4 & 2.8.4, C 3.7 & 15.1)
- Wed 2/14 (11): Eddy viscosity (C 4.1-4.2)
- Mon 2/19: *No class (Presidents' Day)*
- Wed 2/21 (12): Ekman spirals (V 5.7, C 8.3)
- **Fri** 2/23 (13) *(make-up class)*: Ekman transport (C 8.6)
- Mon 2/26 (14): Conceptual description of Ekman transport, Ekman pumping, and Sverdrup transport (V 19.1, C 8.4 & 20.1-20.2)
- Wed 2/28 (15): Western boundary currents in subtropical gyres (C 20.3)
- Mon 3/04 (16): Column-integrated vorticity equation and barotropic streamfunction (V 19.1)
- Wed 3/05 (17): Stommel and Munk solutions for western boundary current (V 19.1-19.2)
- Mon 3/11 (18): Quasigeostrophic approximation, quasigeostrophic potential vorticity equation (V 5.3, C 16)
- Wed 3/13 (19): Rossby waves (V 6.4, C 9.4)
- **Fri** 3/15 (20) *(optional)*: Overview of baroclinic instability (V 19.5 & 19.7-19.8, C 17.3-17.4); Review session
- Sat 3/16 - Sat 3/23: Take-home final exam. You can take the exam during any 24-hour period during final exam week.

Course description

Date, time, location: Mondays and Wednesdays, 11:00-12:20, in Spiess 330.

Synopsis: The course will provide an introduction to the dynamics of rotating stratified flows. Many of the equations apply to both the ocean and the atmosphere, although we will focus primarily on large-scale flows in the ocean. Prerequisits include graduate-level coursework in fluid dynamics or permission of the instructor.

Office Hours: I will informally hold office hours immediately after each class. Students are welcome to email me anytime with questions or to setup a meeting. Students are also welcome to stop by my office anytime, but I recommend checking beforehand to make sure I am in.

Grading: 50% homework, 50% take-home final exam.

Homework: There will be periodic homework assignments. Homework assignments may be turned in one class later than they are due (grace period); let me know if you need more time on an assignment. Students are encouraged to work together on homework exercises; each student should turn in only his or her own work. Please do not consult homeworks or solutions from previous years.

Textbooks: Recommended readings will be drawn from
Atmospheric and Oceanic Fluid Dynamics by Geoffrey Vallis (2017) [individual chapter PDFs or all chapters in single PDF],
Introduction to Geophysical Fluid Dynamics by Benoit Cushman-Roisin and Jean-Marie Beckers (2011) [individual chapter PDFs or all chapters in single PDF].

Other textbooks covering aspects of the material we cover that you may also find useful:
Intro to Physical Oceanography by Robert Stewart (2008) [here],
Atmosphere-Ocean Dynamics by Adrian Gill (1982) [here],
Ocean Circulation Theory by Joseph Pedlosky (1998),
Geophysical Fluid Dynamics by Joseph Pedlosky (1987),
Atmosphere, Ocean and Climate Dynamics by John Marshall & Alan Plumb (2008) [here or here].