SIOC 212A (Winter 2021)

Geophysical Fluid Dynamics I

Instructor: Ian Eisenman (eisenman@ucsd.edu).

Lectures and assignments *(evolving)*

Zoom info for joining lectures: here (access restricted to UCSD community).

Lecture schedule:

- Tue 1/05 (01): Basic equations [relevant textbook sections: Vallis (V) chapter 1, Cushman-Roisin & Beckers (C) chapters 1 & 3]
- Thu 1/07 (02): Rotating coordinate system, geoid (V 2.1, C 2.1)
- Tue 1/12 (03): Coriolis force (V 2.2-2.3, C 2.2 & 2.4-2.5)
- Thu 1/14 (04): Inertial oscillations (C 2.3)
- Tue 1/19 (05): Momentum equation scaling, hydrostatic approximation (V 2.7, C 4.3)
- Thu 1/21 (06): Shallow water equations (V 3.1, C 7.1-7.3)
- Tue 1/26 (07): Geostrophic adjustment (V 3.9, C 15.2)
- Thu 1/28 (08): Potential vorticity (V 3.7.1, C 7.4)
- Tue 2/02 (09): Scaling and balances in shallow water equations, non-rotating adjustment
- Thu 2/04 (10): Boussinesq approximation, stratification, thermal wind (V 2.4 & 2.8.4, C 3.7 & 15.1)
- Tue 2/09 (11): Eddy viscosity (C 4.1-4.2)
- Thu 2/11 (12): Ekman spirals (V 5.7, C 8.3)
- Tue 2/16 (13): Ekman transport (C 8.6)
- Thu 2/18 (14): Conceptual description of Ekman transport, Ekman pumping, and Sverdrup transport
- Tue 2/23 (15): Western boundary currents in subtropical gyres (C 20.3)
- Thu 2/25 (16): Column-integrated vorticity equation and barotropic streamfunction (V 19.1)
- Tue 3/02 (17): Stommel and Munk solutions for western boundary current (V 19.1-19.2)
- Thu 3/04 (18): Quasigeostrophic approximation, quasigeostrophic potential vorticity equation (V 5.3, C 16)
- Tue 3/09 (19): Rossby waves (V 6.4, C 9.4)
- Thu 3/11 (20): Overview of baroclinic instability (V 19.5 & 19.7-19.8, C 17.3-17.4); Review session
- Sat 3/13 - Sat 3/20: Take-home final exam. You can take the exam any day you'd like during this period. I'll email you the exam at the time you select, and it will be due 24 hours later (scanned/photographed and emailed to me).

Recorded lecture videos: Lectures will be recorded and made available to students who are unable to attend in real-time at the link here (access restricted to UCSD community).

Lecture notes: (1) Governing equations, (2) Shallow water, (3) Stratified flow, (4) Wind-driven circulation, (5) Quasigeostrophy, (6) Review.

Homework assignments:

- HW-1 *(due 1/14)*
- HW-2 *(due 1/21)*
- HW-3 *(due 1/28)*

Course description

Lectures: Lectures will be given remotely on Tuesdays and Thursdays at 2:00-3:20 Pacific Time at the Zoom link mentioned above. All lectures will be recorded and made available through this website for those who are not able to join them live.

Access: The course lecture videos, lecture notes, homework assignment and solutions, etc, will be posted on this website and made accessible only to the UCSD community (through VPN or from IP addresses that are added for individual students).

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.

(Zoom) Office Hours: I will informally hold office hours over Zoom immediately after each class. Students are welcome to email me anytime with questions or to setup a Zoom meeting.

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. Homework will be graded on a ✓+, ✓, ✓- basis. Students are encouraged to work together on homework exercises (using Zoom or similar software); each student should turn in only his or her own work. Homework should be turned in via email as a PDF attachment, and I'll grade it and return it as an annotated PDF via email. 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].