# SIO 212A: Geophysical Fluid Dynamics I

[Scripps Institution of Oceanography](#)
[University of California San Diego](#)

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| **Winter 2015** | *Instructors:* Jennifer MacKinnon and Ian Eisenman<br>*Time:* Tuesdays and Thursdays, 9:30 - 10:50<br>*Location:* Nierenberg Hall 101 | SCRIPPS INSTITUTION OF OCEANOGRAPHY |

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### Course Overview

The course will cover basic dynamics of rotating stratified flow, generally applicable to both the ocean and atmosphere. Topics will range from large-scale quasi-balanced flows to small-scale turbulence. Prerequisits include graduate-level coursework in fluid dynamics or permission of the instructor.

### Textbooks

Homework and exams will be based only on material covered in class. Useful additional information can be found in
* "*Atmospheric and Oceanic Fluid Dynamics: Fundamentals and Large-scale Circulation*" by Geoffrey Vallis (2006) [online e-reader here]
* "*Introduction to Geophysical Fluid Dynamics*" by Benoit Cushman-Roisin and Jean-Marie Beckers (2011), [online chapter PDFs here].

### Schedule

*Part 1 (Ian Eisenman)*
1/6: Introduction, basic equations (V 1, C 1 & 3)*
1/8: Rotating coordinate systems, earth's geoid (V 2.1-2.3, C 2)
1/13: Scaling, hydrostatic approximation, Boussinesq approximation (V 2.4-2.7, C 3.7 & 4.3)
1/15: Eddy viscosity, Ekman spirals (V 2.12, C 4.2 & 8)
1/20: Ekman spirals (cont'd), Ekman transport (V 2.12, C 8)
1/22: Ekman pumping, inertial oscillations, dimensionless numbers, shallow-water equations (V 3.1 & 2.8.1 & 2.12.1, C 2.3 & 4.5 & 7.1-7.3)
1/27: Geostrophic adjustment (V 3.8, C 15.2)
1/29: Potential vorticity (V 3.6.1, C 7.4)
2/3: Thermal wind (V 2.8.4, C 15.1)
2/5: Midterm exam [solution]
*Part 2 (Jen MacKinnon)*
2/10:

*Relevant sections in Vallis and Cushman-Roisin textbooks.

**Office hours** (Ian): Students are welcome to stop by my office anytime (Nierenberg Hall 223), but I recommend checking beforehand to make sure I am in. One ideal time is right after class. You can also make an appointment.

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## Homework

Homework #1, due Jan 22. [solution]

Homework #2, due Jan 29. [solution]

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## Quizzes

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There will be a daily quiz at the beginning of some classes, which will be graded on a pass/fail basis. You can miss up to 2 quizzes with no consequence.

There will be homework due every week or two. You are encouraged to work in groups, but please write up your own assignment. Assignments will be posted here when available.

There will be both a mid-term and final exam. In each case you'll be allowed to bring in one 8.5x11 piece of paper covered with whatever you deem appropriate.

Each student will be asked to choose a relevant journal article (with assistance from the instructor) and present it to the class near the end of the quarter.

The final grade will determined as folows: daily quizzes (10%), homework (25%), paper presentation (10%), mid-term (25%), final exam (30%).

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## Other useful references

Some reviews of descriptive physical oceanography:
 - SIO 210: Intro to Physical Oceanography
 - "Intro to Physical Oceanography" by Stewart, open source online textbook (click on each chapter title to go there)

"Atmosphere-Ocean Dynamics" by Adrian Gill

"Geophysical Fluid Dynamics" by Joseph Pedlosky

"Lectures on Geophysical Fluid Dynamics" by our own Rick Salmon (or ask him in person)

"Fundamentals of Geophysical Fluid Dynamics" by James C. McWilliams

"Atmosphere, Ocean and Climate Dynamics, Volume 93: An Introductory Text" by John Marshall and R. Alan Plumb

Turbulence in the ocean and atmosphere:
 - "An Introduction to Turbulence" and "The Turbulent Ocean", both by Steve Thorpe. These are excellent surveys of the primary processes producing turbulence and turbulence mixing in the ocean, intended for an advanced undergraduate audience.

- "A first course in turbulence" by Tennekes and Lumley.  A good theoreticaly rigorous treatment of turbulent flows, vorticity dynamics, spectral methods and turbulent closures.
- "Small scale processes in geophysical fluid flows" by Kantha and Clayson. Another excellent text, aimed at the graduate level, covering a range of processes (especially boundary layer dynamics) in both atmosphere and ocean.

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