Physical Oceanography

ATS 610, Department of Atmospheric Science
10:00-10:50 AM Monday, Wednesday and Friday, 2020 Spring Term
212B ACRC

Instructor Contact Information

Prof Peter Jan van Leeuwen
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Office hours: By appointment

Course Description

This course tries to answer two basic questions: why does the ocean flow as it does, and how does it interact with the other Earth system components. We start with a quick tour of what we see in direct observations of the ocean. Then the characteristics of seawater are discussed, followed by a review of the equations of motion. Emphasis will be on potential vorticity and the important Taylor-Proudman theorem. This is followed by discussions of the wind-driven circulation and Ekman dynamics, stratification and the ventilated thermocline, waves, dynamic stability, mixed-layer dynamics and the dynamics of ocean eddies.

After this general description we dive into the different parts of the ocean, focusing on equatorial dynamics, the polar oceans and sea-ice, interocean exchanges and the global ocean circulation. On top of this we will discuss one or two subjects that the students bring up, e.g. role of the ocean in the carbon budget, marine biology and biogeochemistry, oceans on other planets.

Since this is a graduate level course the emphasis is strongly on understanding and less so on derivations. Discussions are the central element of the course, facilitated by questions from teacher and students, student presentations, past and recent papers that either were the first to present important new ideas or contain in-depth discussions.

Course goals

Students who complete this course successfully will be able to:
- describe and explain the origin of the present-day ocean circulation,
- have a critical understanding of the role of the ocean in the weather and climate system,
- critically evaluate the literature on this subject

Course materials

Detailed lecture notes will be available on Canvas in due course. The instructor does not use a specific textbook. The following textbooks provide basic and advanced material that relate to the course:
Henk A. Dijkstra (202008) Dynamical Oceanography, Springer
Joseph Pedlosky (1996) Ocean Circulation Theory, Springer.

Grading

The grading will be based on a small number of assignments, including running a simplified ocean model to study basic ocean circulation, student presentations and participation in discussions.

Overall structure

The following subjects will be covered:

1) What does the ocean look like: characteristics of seawater and present-day ocean circulation
2) Governing equations: potential vorticity, Kelvin's Theorem, Tayor-Proudman theorem
3) Wind-driven circulation, Ekman dynamics, Sverdrup Balance and western intensification
4) Ocean stratification and the ventilated thermocline
5) Barotropic and baroclinic waves and ocean eddies
6) Stability of ocean flows
7) Mixed-layer dynamics
8) Equatorial Circulation and ENSO
9) Polar Oceans and sea-ice dynamics
10) Interocean circulations
11) Global Circulation
12) Paleooceanography

On top of this we will discuss one or two subjects that the students bring up, e.g. role of the ocean in the carbon budget, marine biology and biogeochemistry, oceans on other planets.

Statement on Academic Integrity

This course will adhere to the CSU Academic Integrity Policy as found in the General Catalog (http://www.catalog.colostate.e and the Student Conduct Code (http://www.conflictresolution.colostate.edu/conduct-code). At a minimum, violations will result in a grading penalty in this course and a report to the Office of Conflict Resolution and Student Conduct Services.

Disclaimer

The instructor reserves the right to make modifications to this information throughout the semester.