Ocean Dynamics and Fundamentals of Large-Scale Ocean Circulation

EAS - 6672

Spring 2021
T-Th 9:30-10.45am
Room ES&T L1116

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Textbooks: *Atmospheric and Oceanic Fluid Dynamics* by G. Vallis, Cambridge Univ. Press, Nov 2006 and subsequent editions (Preferred option).
Essentials of Atmospheric and Oceanic Dynamics, by G. Vallis, Cambridge Un. Press, 2019

Course overview

An advanced class for graduate students in Oceanography and Climate Science that considers the ocean as a dynamical system and studies the basic equations governing it, together with its variability. This course includes a theoretical component and one involving a combination of observations, theory and numerical modeling relevant to understand the large scale ocean circulation. We will use papers from the literature and materials from the reference texts indicated. It is recommended having one of the two books.

Pre-requisite: Physical and Chemical Oceanography (EAS – 4803) and/or one of the following: Introductory Fluid Dynamics (EAS – 6502); Atmospheric Dynamics (EAS - 4655), Mathematical Methods for GFD (EAS – 8803). Knowledge of partial differential equations is REQUIRED.

Outline

Week 1: Ocean circulation and climate variability: An Introduction.

Week 2-4: The Wind-driven circulation: Phenomena, shallow water and QG models, the Stommel model and alternative formulations, the nonlinear problem, topographic effects, regimes, the turbulent solutions.

Week 5-7: East Boundary Current systems: role in climate and biogeochemical cycles; similarities and differences

Week 8: Partial review and Midterm Exam

Week 9-10: The thermohaline circulation: Simplified models

Week 11-12: The thermohaline circulation: 3D and coupled models its variability and potential mechanisms. The North Atlantic and the Southern Ocean.

Week 13-15: Equatorial circulation and ENSO: its phenomenology, physics, models. Cane and Zebiak, the delayed oscillator, coupled processes, the ENSO seasonal cycle

Week 16: ENSO: past and future

Finals

Course evaluation

Attendance and active participation in class: 10%
Homework and problem sets: 30%
Midterm exam: 30%
Final: 30%
A group project can substitute the final (to be discussed during the first week).