Basic Dynamical Oceanography

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Course Overview

Understanding the steady, large-scale circulation of the ocean: Why is the surface, wind-driven flow perpendicular to the wind forcing? How do winds drive gyre-scale flows well below the wind-driven layer? Which types of flow are geostrophically balanced? Why are there Western Boundary Currents? And eastern boundary upwelling? Why is potential vorticity useful? Why does the Agulhas Current retroflect?

Prerequisites: It will be assumed that you know derivatives and partial derivatives, integrals, scalars and vectors, gradient, divergence, and curl.

Course requirements: Study questions are provided throughout the course and students will be expected to present solutions in class.

Recommended Books

Robert Stewart (RS): *Introduction to Physical Oceanography* - full text online.
John Knauss (JK): *Introduction to Physical Oceanography.*

Other Books and Further Reading

Pond and Pickard (PP): *Introductory Dynamical Oceanography*
Open University (OU): *Ocean Circulation*

Course Outline

(0) Forcing of the Ocean - tides, winds, and heating (RS4-5,JK3,OU1-2)
(1) Mass, energy, and salt conservation; continuity equation (PP4,JK4,0U6,PP10)
(2) Equations of Motion on a rotating planet - Coriolis force and inertial oscillations (JK5,PP6,OU3)
(3) Scaling - relative importance of the terms in the equations of motion (PP7)
(4) Ekman layers and Ekman spiral (PP9,JK5-6,OU3,RS9)
(5) Geostrophy - thermal wind and dynamic height method (RS10,PP8,JK6,OU3)
(6) Potential vorticity equation - concept of curl/spin/vorticity (PP9,JK5,RS12)
(7) The Sverdrup balance and gyre circulation (RS11,PP9,JK6)
(8) Western intensification (RS11,PP9,OU4)
(8a) The Agulhas Current - a case study of a Western Boundary Current
(9) Upwelling - equatorial, coastal, and Antarctic (OU5,JK7,RS14)
(10) Abyssal circulation (RS13,PP10,OU6)