Université de Bretagne Occidentale

MASTER PHYSIQUE

PARCOURS PHYSIQUE OCÉAN ET CLIMAT

semestre 9 Physique POC

SPÉCIALITÉ HAUTURIÈRE

Circulation océanique générale

Présentation

4 crédits ECTS

Volume horaire

Cours Magistral : 20h
Travaux Dirigés : 15h

Ce cours traite des processus physiques qui controlent l'hydrodynamique de la circulation oceanique generale. Une approche GFD permet de generaliser a d'autres cas, les processus physiques etudies ici, en utilisant des nombres adimensionnels similaires. En effet, nombre de ces processus existent dans l'atmosphere

This is a course about the physical processes which control the hydrodynamics of the open ocean circulation. A GFD approach allows to export elsewhere the physical processes learned herein if the governing adimensional numbers are in the same range. Indeed many of these processes are also active in the atmosphere.

This course aims at introducing the General Circulation of the Ocean to non specialists, starting from geophysical fluid dynamics. Firstly, we show physical manifestations of large-scale currents, such as gyre flows, the thermohaline circulation (conveyor belt), and inter-bassin exchanges. The coupling with the atmosphere is mentioned, in particular for climate applications.

Then the wind and buoyancy currents in a homogeneous ocean are detailed, in particular the Sverdrup and Stommel models. Then the wind induced and density gradient induced currents at basin scale are presented in a stratified ocean.

The last part of the course will focus on the tropical dynamics. First theory of the ventilation of the tropical thermocline will be introduced and linked with the subtropical thermocline ventilation theory (ventilated thermocline). Theory of the Equatorial UnderCurrent (EUC) dynamics will be then exposed, including the different dynamical regimes of the EUC (inertial, wind forced, viscous models). Eventually, theory of the transient dynamics within the equatorial band including equatorial trapped waves and jets, as well as equatorial basin adjustment theory.

Objectifs

this course is designed for deep ocean dynamics specialists. It details the mechanisms underlying the general circulation of the ocean. In particular, focus is put on the ocean response to various forcings (mechanical, thermodynamical) and on the difference, in that response, at the Equator and athigher latitudes. The objective is to provide a physical basis for the understanding of eddy-resolving numerical simulations of the ocean. The physical tools (potential vorticity diagnostics, energy equations) are provided.

une connaissance quantitative des theories visant a expliquer les observations. Les limites de ces theories. Les problemes de recherche actuels.

Pré-requis nécessaires

dynamique des fluides geophysiques

mathematical analysis : ODEs, PDEs, real functions of several variables;

physics : fluid mechanics, thermodynamics, geophysical fluid dynamics,

Compétences visées

comprendre la circulation generale des oceans et son role dans la variabilite climatique

maitriser les theories fondamentales de la circulation oceanique et etre capable de les utiliser pour valider les resultats d'un modele numerique

understanding the general circulation of the ocean and its role in climate variability

ability to identify scientific questions

ability to use these results for scientific projects

ability to validate numerical results with theoretical results

use for problem solving in fluids

contributes to a global approach (holistic approach) to problem solving
use for building numerical algorithms for professional purposes

mastering the basic theories of ocean circulation and being able to use them to validate the results of a numerical model

Descriptif

1. Questions to be asked and Basic approximations: geostrophy and hydrostatics

The ocean as a homogeneous fluid

2. Wind driven ocean circulation, Sverdrup theory
3. Potential vorticity, Quasi-geostrophy, Western intensification and western boundary currents
4. Rossby waves
5. Nonlinear inertial effects, Barotropic instability

The ocean as a stratified fluid

6. Quasi geostrophy again
7. Modal decomposition, Rossby waves again
8. The spin up of the wind driven ocean circulation and Gill's catastrophy
9. The vertical structure of the wind driven circulation (the ventilated thermocline and Rhines-Young's ideas)
10. Baroclinic instability
11. The thermohaline circulation, The vertical mixing problem, Stommel-Arons's type ideas for the abyssal circulation, The shut down of the circulation.

Tropical and Equatorial Dynamics

- Tropical thermocline ventilation
- Theory of the Equatorial Under Currents circulation
- Equatorial Waves and adjustment
- Tropical ocean-atmosphere coupling : ENSO theories

Bibliographie

ACdV Lecture notes Oceanic Circulation (in French) # stockage.univ-brest.fr/~acolindv
Gill, Atmosphere-Ocean dynamics
Pedlosky's books (The ocean circulation and his GFD book)
Holton, Dynamic Meteorology

Modalités de contrôle des connaissances

Session 1 ou session unique - Contrôle de connaissances

Nature de l'enseignement	Modalité	Nature	Durée (min.)	Coefficient	Remarques
	CC	Autre nature		50%	
	CT	Ecrit - devoir surveillé	150	50%	

Session 2 : Contrôle de connaissances

Nature de l'enseignement	Modalité	Nature	Durée (min.)	Coefficient	Remarques
	CT	Oral	40	100%	oral commun de 40 mn pour toutes les matières