MASTER PHYSIQUE

## PARCOURS PHYSIQUE OCÉAN ET CLIMAT

**semestre 9 Physique POC**

# Dynamique des fluides géophysiques

**3 crédits ECTS**

Volume horaire

Cours Magistral : 17h
Travaux Dirigés : 10h

## Présentation

This course provides the bases of GFD to understand planetary fluid motion, via mathematical theories, exercises, lab experiments and possibly data analysis

This course aims at introducing Geophysical Fluid Dynamics to non specialists, starting from fluid dynamics. It establishes the equations governing rotating stratified fluids and the various approximations of these equations: shallow-water equations, quasi-geostrophic equations, geostrophic, hydrostatic balance and thermal wind balance. The frictional equations (forced/dissipative systems) are also presented (Ekman flows). Then the shallow-water equations are solved for linear waves, vortex flows, upwellings. An introduction to the general circulation of the ocean is provided.

This course is taught in English.

## Objectifs

Objectives

Knowing GFD to understand ocean and atmosphere motions - application to other M2 courses and professional applications

this is the basic course upon which specialized ocean dynamics courses (coastal dynamics, mesoscale dynamics, general circulation, internal waves, flow instability, turbulence) will be based.

## Pré-requis nécessaires

Pre-requisite : Knowledge of

mathematical analysis : ODEs, PDEs (preferably), real functions of several variables, geometry of curves and surfaces, vector analysis ;

physics : incompressible (homogeneous and stratified, non rotating) fluid mechanics, thermodynamics

## Compétences visées

This course contributes to gaining the following abilities

mastering theory to analyse complex oceanic situations to identify basic physical mechanisms, to analyse datasets or to understand the underlying equations of numerical models.

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

## Descriptif

Contents

Introduction/ to the ocean and atmosphere system

Establishing the Boussinesq equations for momentum, energy and vorticity ; application to convection and to internal waves

Primitive (hydrostatic 3D) equations; scaling; geostrophic and hydrostatic balance; thermal wind balance

Quasi-geostrophic motion in a continuously stratified rotating fluid; energy and potential vorticity; vertical modes; Rossby waves

Shallow water model; TPP theorem; momentum equations, potential vorticity, divergence equations, energy equation.

Shallow water linear waves : Pure gravity waves, inertial motion, Poincare/inertia-gravity waves, Kelvin waves, Rossby waves (planetary and topographic), coastal waves

Frictional motions / Ekman equations (wind stress forcing, bottom friction)

introduction to the wind forced general circulation of the ocean
Vortex motions
Upwelling dynamics

## Bibliographie

*G Vallis, Atmospheric and Oceanic Fluid Dynamics, Cambridge University Press*
*J Pedlosky, Geophysical Fluid Dynamics, Springer Verlag*

## Modalités de contrôle des connaissances

### Session 1 ou session unique - Contrôle de connaissances

| Nature de l'enseignement | Modalité | Nature | Durée (min.) | Coefficient | Remarques |
|---|---|---|---|---|---|
| Cours Magistral | 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 |
|---|---|---|---|---|---|
| | Autre modalité | Autre nature | | | oral commun de 40 mn pour toutes les matières |