Doctorate School in Earth Science and Fluid Mechanics (ESFM) - XXXI Cycle
Postgraduate Diploma Programme in Earth System Physics – year 2015/2016 (II Term)

Program of the course:
Introduction to Geophysical Fluid Dynamics (ESP-GFD)

- Introduction to Geophysical Fluid Dynamics (GFD): Scales of motion in GFD – Importance of rotation and of stratification – Principal distinctions between atmosphere and oceans

- The rotating frame of reference: The Coriolis force and the centrifugal force – Motion of a free particle on a rotating frame: inertial oscillations – Acceleration on a three-dimensional rotating planet

- The governing equations of GFD: Momentum equations – Mass conservation – Energy equation – Equation of state – The Boussinesq approximation – Scales of motion in geophysical flows: further simplifications of the governing equations – The Rossby and Ekman numbers: link with the Reynolds number

- Rotation 1: Geostrophic balance: Homogeneous geostrophic flows – The Taylor-Proudman theorem - Homogeneous geostrophic flows over an irregular bottom – Generalization to non-geostrophic flows – Vorticity dynamics: definition of potential vorticity

- Rotation 2: The importance of friction: The bottom Ekman layer – The surface Ekman layer – The Ekman layer over uneven terrain – The Ekman layer in real geophysical flows

- Rotation 3: Barotropic waves: The Kelvin wave – Inertia-gravity waves (Poincarè waves) – Planetary waves (Rossby waves) – Topographic waves – Analogy between planetary and topographic waves

- Stratification 1: Static stability – The Brunt-Vaisala frequency – The Froude number – Combination of rotation and stratification

- Stratification 2: Mixing of stratified fluids – Kelvin-Helmoltz instability – Instability of a stratified shear flow – Taylor-Goldstein equation and the Richardson number – Turbulence in a stratified shear flow – The Monin-Obukhov length

Reference text: Introduction to Geophysical Fluid Dynamics, by B. Cushman-Roisin, Prentice-Hall.