PROPOSITION DE SUJET DE THESE

Ecole Doctorale Terre-Univers-Environnement

Mixing along oceanic slopes : the role of internal gravity waves

Laboratory : LEGI, UMR 5519

Place of PhD work : LEGI, 1025 rue de la piscine, Saint-Martin d'Hères (France)

Name of thesis advisor : Chantal Staquet (ERES team)

E-mail : Chantal.Staquet@hmg.inpg.fr

Collaboration : groupe Coriolis (LEGI)

Cold waters at high latitude sink to the bottom of the ocean, flow toward the equator along the submarine topography and slowly upwell toward the surface while mixing. The main contributor to oceanic mixing is internal (gravity) wave breaking. These waves are created by the stable density stratification which exists almost everywhere in the ocean, and are the analogue in volume of surface gravity waves. Internal waves are ubiquitous in the ocean, being mainly created by the tide and the wind. These waves thus play a fundamental rôle in the global thermal equilibrium of the ocean, through the abyssal mixing they induce.

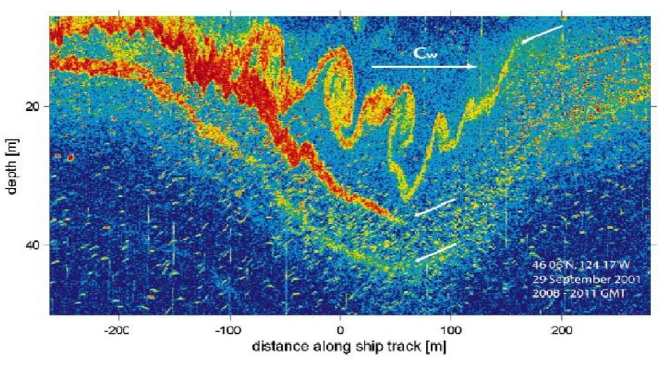
The potential rôle of internal waves in oceanic mixing has launched a new interest among the oceanic community for about ten years. Several questions need indeed to be addressed, which are both fundamental and operational: (i) what is the energetic content of these waves? (ii) where do their dissipation processes occur and what is the value of the associated turbulent diffusivity? How to parameterize the effect of these waves in large scale numerical circulation models?

An intriguing phenomenon leading to internal wave dissipation arises when the waves approach a submarine topography. As they reflect onto the topography indeed, a part of their energy can be transferred to nonlinear structures propagating along the boundary, which intensify boundary mixing. Another example is when the internal waves get close to the continental shelf, which is a shallow region (about 200 m deep) near the coasts. The waves may transform into strongly nonlinear structures, referred to as solitons, as they enter the shelf from the open ocean. These nonlinear structures may become unstable, possibly mixing the whole water column, so that oxygen is carried down from the surface to the bottom of the shelf while bottom marine or biological species are transported toward the surface. Investigating the nonlinear transformation process of internal gravity wveas and the induced mixing is thus of great interest, both from a fundamental and practical view point.

The objectives of the PhD thesis is to study the conditions of occurrence of such nonlinear structures when internal gravity waves meet a topography, the dynamics of these structures and the induced mixing. Numerical simulations using the MIT-gcm code (which our team has been using for many years) will be performed for this purpose. The validity of the numerical results will be evaluated by comparison with results from laboratory experiments performed in parallel on the Coriolis platform, in which the student may take part. The overall objective of the PhD work is to consider eventually the realistic configuration of the Bay of Biscay, to compare the numerical data with available measurements in the Bay and to propose a parameterization of the mixing associated with the nonlinear structures.

The PhD work will be part of an ANR project, named PIWO (Physics of Internal Waves for Oceanography), which started in January 2009. This project involves the team of Francis Auclair in Toulouse (Pôle d'Océanographie Côtière and Laboratoire d'Aérologie), Thierry Dauxois in ENS Lyon and part of the ERES team in LEGI. Natural collaboration between the student and these teams will therefore be part of the PhD work.

Required knowledge and skills: the student should have a solid background in fluid mechanics and a good expertise in numerical simulations. A good knowledge of english is mandatory.



Kelvin- Helmholtz instability of a soliton-like nonlinear structure, obtained from acoustic measurements in the ocean (Moum et al., J. Phys. Ocean., 2003)