Geophysical Research Abstracts
Vol. 13, EGU2011-10138-1, 2011
EGU General Assembly 2011

Interaction of internal gravity waves generated over a ridge with strong density gradients

Yvan Dossmann (1,2), Francis Auclair (2), and Alexandre Paci (1)

(1) CNRM-GAME, URA 1357, Météo-France/CNRS, Toulouse, France (yvan.dossmann@gmail.com), (2) Laboratoire d'Aérologie, UMR 5560, CNRS/Université Paul Sabatier Toulouse III, France

Internal tides are known to play an important role in sustaining the General Oceanic Circulation [1]. Although the exact origin of the energy conversions occurring in stratified fluids is being questioned [2] it is clear that the diapycnal energy transfers provided by the cascade of internal waves in high bathymetric gradients regions is strongly linked to the General Circulation energy balance.
The interaction of internal tides with regions of sharp density gradients involves important nonlinear effects, potentially leading to the local generation of internal solitary waves. These solitons are responsible for important energy transfers, as they initiate turbulent mixing while they propagate in the pycnocline. Therefore, their generation and propagation processes are a crucial point of study.
In the last 10 years, there has been a growing interest in the understanding of the physical mechanism underlying the generation of solitons in the pycnocline. Gerkema [3] and Akylas [4] extracted nondimensionless physical parameters controlling this generation.

Our work relies on numerical simulations to quantify the efficiency of the energy transfers from an impinging internal wave ray generated over a ridge to nonlinear structures in the pycnocline, in various regimes associated with different physical configurations. These simulations will enable to prepare laboratory experiments in the large stratified tank of the CNRM-GAME fluid mechanics laboratory that will complement the numerical study.

Simulations are conducted using the numerical model of regional oceanic circulation Symphonie [5]. Symphonie is an energy conserving model [6], with a non-hydrostatic version, pertinent for the study of internal wave energetics. This model is used to carry out direct numerical simulations (i.e with no turbulence schemes) of internal waves generation by the oscillation of a 2D Gaussian ridge in a linearly stratified bottom layer that interacts with a pycnocline close to the surface of the fluid, at the laboratory scale. The typical resolution of 1mm is adapted to the forcing amplitude, what enables to simulate small scale non linear processes.

A major stake of our work is to quantify the influence of a limited number of dimensionless physical parameters on the generation of nonlinear processes in the pycnocline, due to an impinging internal wave ray. In our study, the internal wave ray interacting with the pycnocline is directly generated over the Gaussian ridge, and not theoretically prescribed. The forcing frequency is chosen to generate near critical internal wave rays over the ridge, which transport a maximum energy away from the generation zone [7], what enables a stronger interaction with the pycnocline.
Combined Wavelet and EOF analyses are performed to extract coherent physical features from the bidimensional velocity and density anomaly fields but also from isopycnal displacements. These combined analyses enable to separate the nonlinear structures from the linear forcing internal wave, and thereby to isolate the solitary wave structure that potentially emerges.
In order to synthetize the description of the interaction between the internal wave and the pycnocline, we draw a diagram displaying the different regimes observed in the pycnocline with respect to relevant physical parameters. In particular, this diagram highlights the relevant parameters for an efficient energy transfer from internal wave rays to internal solitary waves.
For an oceanographic purpose, this study is a step towards a better understanding of the energy transfers in the regions where internal waves interact with high density gradients.

References

[1] Munk W. and Wunsch C., 1998. Abyssal recipes II: energetics of tidal and wind mixing. Deep-Sea Res. 45, 1977-2010 .

[2] Tailleux R., 2009. On the energetics of stratified turbulent mixing, irreversible thermodynamics, Boussinesq models and the ocean heat engine controversy, J. Fluid Mech. 638, 339-382 .

[3] Gerkema T., 2001. Internal and interfacial tides: Beam scattering and local generation of solitary waves. Journal of Marine Research, 59, 227-255.

[4] Akylas T.R., Grimshaw R.H.J., Clarke S.R., Tabaei A., 2007. Reflecting tidal wave beams and local generation of solitary waves in the ocean thermocline. Journal of Fluid Mechanics, 593, 297–313.

[5] Auclair F., Estournel C., Floor J.W., Herrmann M., N'Guyen C., Marsaleix P., 2011. A non-hydrostatic, energy conserving algorithm for regional ocean modelling, In Press, Ocean Modelling.

[6] Floor J.W., Auclair F., Marsaleix P., 2010. Energy transfers in internal tide generation, propagation and dissipation in the deep ocean, In Press, Ocean Modelling.

[7] Dossmann Y., Paci A., Auclair F., Floor J.W., 2010. Simultaneous velocity and density measurements for an energy-based approach to internal waves generated over a ridge. Submitted to Experiments in Fluids.