

Barotropic to Baroclinic Energy Conversion Across Topographically Rough Straits with Application to the Luzon Strait

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LONG-TERM GOALS

This is a joint UNC-UCSD proposal whose main goal is to assess the relative contribution of local dissipation versus far-field radiation of internal waves generated by the barotropic tide flowing across topographically rough straits in the Western Pacific, with special emphasis on the Luzon Strait Area. In this report, we focus on the UNC contribution.

OBJECTIVES

1. Quantify the conversion rate of Barotropic to Baroclinic energy over rough topography;
2. Quantify the amount of IW energy dissipated locally vs. the amount radiated into the far field;
3. Examine the physical processes leading to dissipation at small scale;
4. Understand the formation of Nonlinear Internal Waves emerging from the Luzon Strait.

APPROACH

The idea is to use a combination of large/intermediate scale numerical model (GCM) , small scale turbulence models (LES) and theoretical models to explore the multiscale process that begins when the large-scale barotropic tide injects energy into the baroclinic field.

WORK COMPLETED

On the theoretical side, we have derived a model for the transient generated by IW interacting with topography which predicts how much shear can raise above mid-ocean values during the interaction with topography. We have acquired a Digital Elevation Model of the Luzon Strait area. With the aid of

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climatological data (GFDL) we have calculated maps showing how much the Richardson number can be elevated above the value observed without boundary interaction.

Following a discussion at the last meeting in Honolulu, we have also run simulation of linear mode-1 internal waves approaching at different angles, to test the hypothesis that NLIWs are generated by the confluence of linear IWs approaching from different directions.

RESULTS

The model shows that the transient can lead to a large intensification of the shear. The Richardson number during the transient can be elevated up to a factor $(\omega/(\omega - \omega_c))^4$ above undisturbed levels. Figure 1 shows a map of the intensification factor for waves at the diurnal frequency and near-bottom stratification from climatology. Interestingly, most of the western ridge is an area of potential dissipation for the IWs at the diurnal frequency whose impact needs to be better understood.

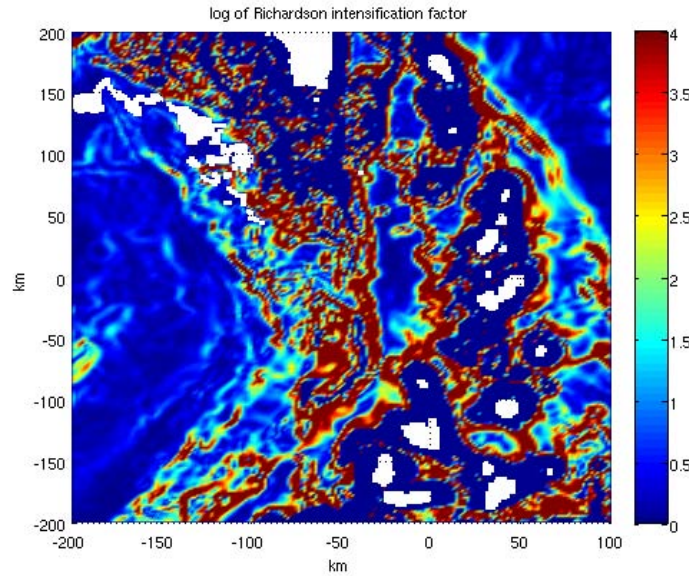


Figure 1: Map of the Richardson number intensification factor for Internal Waves at the diurnal frequency. The factor is plotted in logarithmic scale. The map is centered on the Luzon Strait, with the tip of Taiwan to the north. Shallow areas near the Baatan Islands are blocked out. Note the large values attained near the western ridge. Stratification data from GFDL climatology.

We have also conducted numerical experiments with the UNC Ocean Model to study the three-dimensional interaction of linear internal wave packets approaching at small grazing angle. This was done to see if the interaction of linear waves coming from different sources within the Luzon Strait can lead to NLIWs by a process of constructive interference. Preliminary results show that this is indeed the case. The goal is to characterize the range of angles that lead to NLIWs.

IMPACT/APPLICATIONS

We are working towards a better characterization of multiscale processes that take energy from the barotropic field (ultimately, astronomical scales) to dissipation via several nonlinear processes. The

theoretical characterization of enhanced shear has far-reaching applications, since IW scattering from topography is a phenomenon which occurs on a global scale, and it is linked to the control of the meridional overturning circulation. It thus has a profound aspect on climate control.

RELATED PROJECTS

Parts of this project overlap with an NSF project on mixing along continental shelf slopes. The overlap mostly consists in the similarity of the technical tools needed.