Comparison of computed internal tides to observed dissipation

Saeed Falahat, Jonas Nycander and Fabien Roquet
Dept of Meteorology, Stockholm University, Sweden

Much of the internal wave field in the deep ocean is generated by tides flowing over rough topography. The vertical mixing caused by the breaking of these waves is essential for the overturning circulation, and it is therefore important to calculate the internal tides correctly, for example in order to parameterize the vertical mixing in ocean general circulation models.

A practical method of computing the generation of internal tides was developed by Nycander (2005). In this method, which is based on linear wave theory, the energy conversion from the barotropic tide to internal waves at some point $\mathbf{r}$ is obtained by computing a convolution integral of the topography over a region around $\mathbf{r}$. The input data are the bottom topography, the stratification and the tidal parameters.

There are two important error sources in these computations. First, they are based on linear theory, which is not valid if the slope of the bottom topography is supercritical. Second, the resolution of the global topographic data is insufficient. It is therefore essential to verify the results.

The work by Green and Nycander (2013) provides some verification. They used the computed energy conversion field to parameterize the wave drag in a barotropic tidal model, and then evaluated the performance of the tidal model against satellite altimetry. The performance improved significantly when using the parameterization based on Nycander (2005) as compared to two other previously suggested parameterizations that are based on simple scaling arguments.

In the present work we compare the computed energy conversion to the energy dissipation observed in several microstructure surveys. The most abundant data come from the Brazil Basin Tracer Release experiments in 1996 and 1997 (BBTRE1 and BBTRE2, respectively), conducted in a large region of rough topography near the Mid-Atlantic Ridge. For each observed dissipation profile, a time series of the energy conversion at the ocean floor was computed using the method of Nycander (2005). The eight most important tidal constituents were included in the computations in order to capture neap tides and spring tides. The computed conversion was averaged over a region around the experimental sites, and over a time period preceding the dates of the experimental observations. Also, the observed energy dissipation profile was integrated up to a prescribed height above the bottom.

For the BBTRE data, the strongest correlation between observed and computed values was obtained when the radius of the averaging region was at least as large as the wavelength of the first internal wave mode, when the averaging period was three days, and when the upper integration boundary was 2500 m above the bottom. Figure 1 shows a scatter plot of the results for these parameter values. The correlation is 0.66 in this case.

The observed energy dissipation and the computed energy conversion were then both averaged over all the points of the BBTRE surveys, using the same optimal parameters as in Fig. 1. The ratio between the observed and the computed averages was 0.34. A plausible interpretation is that a third of the internal tides dissipate locally in the bottom 2500 meters, while the rest escape into the thermocline and away from the region of rough topography.

We also analysed data from the survey LADDER (LArval Dispersal along the Deep East-pacific Rise). In this case the average computed energy conversion was about fifty times larger than the observed energy dissipation. One reason may be that the sharp topography in this case is limited to a few steep seamounts, and the generated internal tides can therefore more easily escape and propagate away from the experimental region. It is also likely that the linear computations overestimate the energy conversion at supercritical topography.

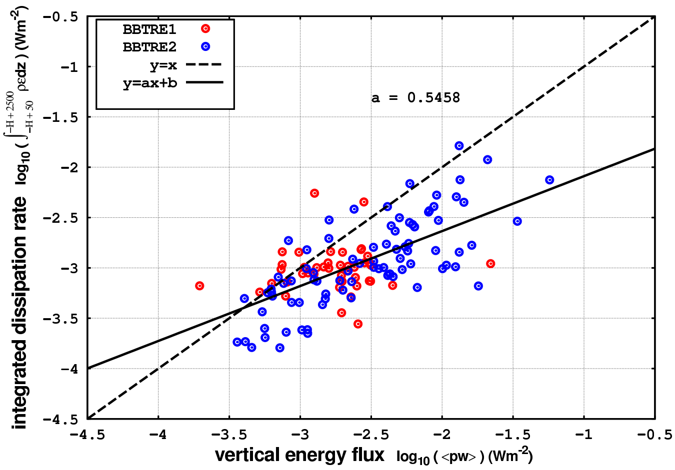

Figure 1: Logarithmic scatter plot of the energy dissipation integrated up to 2500 m above the bottom versus the average of the last 72 hours of the energy conversion for 127 stations from the BBTRE1 and BBTRE2 experiments.

References

Green, M. and J. Nycander, 2013: A comparison of tidal conversion parameterizations for tidal models. J. Phys. Oceanogr., **43**, 104–119.

Nycander, J., 2005: Generation of internal waves in the deep ocean by tides. J. Geophys. Res., **110**, C10028, doi:10.1029/2004JC002487.