On the efficiency of turbulent mixing in the ocean: observations above a deep sloping topography.

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Introduction

The efficiency of a mixing event is related to the fraction of turbulent kinetic energy transferred into irreversible diapycnal exchange. Although it is commonly accepted that the mixing efficiency is not constant but rather varies with time during the evolution of turbulence, a constant value for the flux coefficient ($\Gamma = 0.2$) is still widely used (see discussion in [1]). Exploiting the high spatial *and* temporal resolution the temperature sensors developed at the NIOZ, the efficiency of mixing above a deep sloping topography is investigated. The region under the scope of the study is the Rockall Bank area (Fig. 1a), which is known for being the host of topographically-trapped diurnal internal tides.

Method & Results

The dataset used in this study consists of an array of 119 NIOZ-4 temperature sensors, sampling the water column at 1 Hz from 7 m to 126 m above the bottom. The mooring was deployed for 9 days (8-16 October 2012) on the southeast slopes of Rockall Bank, in a water depth of 919 m (Fig.1a). Individual profiles obtained from the moored sensors were first converted into density and then sorted into monotonic stable profiles from which the "Thorpe scale" L_T [2] and the available potential energy of fluctuation ξ [3] were calculated. The dissipation rate of turbulent kinetic energy (ϵ) was then calculated from L_T [4] and the diapycnal buoyancy flux (J_b) from ξ [3]. This allows the calculation of the instantaneous flux coefficient $\Gamma = \frac{J_b}{\epsilon}$, a measure of mixing efficiency (Fig. 1b). Observations suggest that on average, $\Gamma \approx 0.2$ is a reliable estimation for the flux coefficient in stratified water above sloping topography. Higher values are however observed during the transition between the downslope and the upslope phases of the diurnal tidal cycle, reaching $\Gamma = 0.36 \pm 0.01$ on average. This transition phase occurs quickly when a bore-like frontal structure propagates upslope (Fig. 1b). Such high mixing efficiencies are likely the result of convective instabilities associated with this bore.

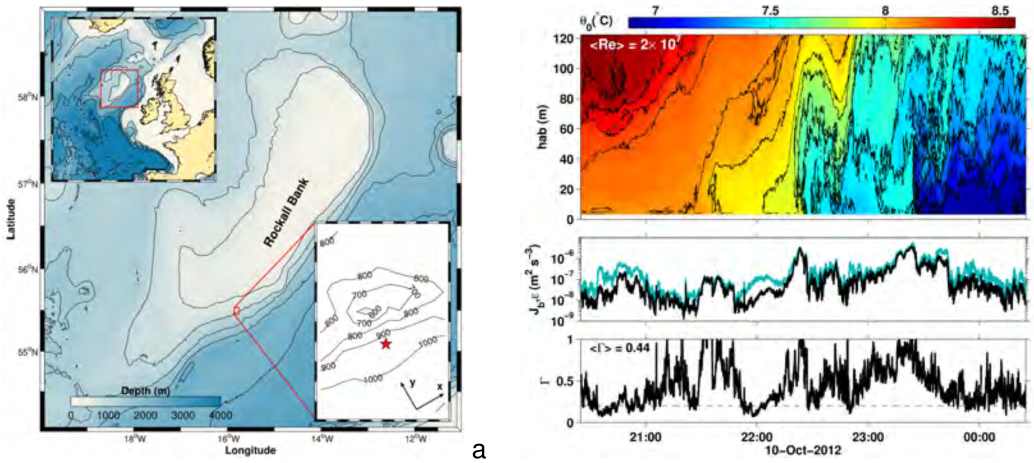

Fig. 1: The arrival of a diurnal tidal front at Rockall Bank. **a.** Mooring location (red star). **b.** 4-hour time series of temperature in function of the height above bottom hab (upper), together with the vertical average of ϵ, J_b (middle, respectively blue and black) and Γ (bottom, dashed-line is $\Gamma = 0.2$).

References

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