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Mixing induced by a propagating normal mode in long term experiments

Yvan Dossmann (1,2), Florence Pollet (2), Philippe Odier (2), and Thierry Dauxois (2)

(1) LEMTA, Université de Lorraine, Nancy, France, (2) Laboratoire de Physique, Univ Lyon, ENS de Lyon, Univ Claude Bernard, CNRS, 69342 Lyon, France

The energy pathways from propagating internal waves to the scales of irreversible mixing in the ocean are numerous. The triadic resonant instability (TRI) is an intrinsic destabilization process that can lead to mixing away from topographies. It consists in the destabilization of a primary internal wave generation leading to the radiation of two secondary waves of lower frequencies and different wave vectors. In the process, internal wave energy is carried down to smaller scales.

A previous study focused on the assessment of instantaneous turbulent fluxes fields associated with the TRI process in laboratory experiments [1].

The present study investigates the integrated impact of mixing processes induced by a propagative normal mode over long term experiments using a similar setup. Configurations for which the TRI process is either favored or inhibited are tackled. Optical measurements using the light attenuation technique allow to follow the internal waves dynamics and the evolution of the density profile between two runs of one hour typical duration. The horizontally averaged turbulent diffusivity $K_t(z)$ and the mixing efficiency Γ are assessed. One finds values up to $K_t = 10^{-6}$ m^2/s and $\Gamma = 11$ %, with slightly larger values in the presence of TRI. The maximum value for K_t is measured at the position(s) of the maximum shear normal mode shear for both normal modes 1 and 2.

The development of staircases in the density profile is observed after several hours of forcing. This mechanism can be explained by Phillips' argument by which sharp interfaces can form due to vertical variations of the buoyancy flux. The staircases are responsible for large variations in the vertical distribution of turbulent diffusivity.

These results could help to refine parameterizations of the impact of low order normal modes in ocean mixing.

Reference :

[1] Dossmann et al. 2016, Mixing by internal waves quantified using combined PIV/PLIF technique, Experiments in Fluids, 57, 132.