Master 2 project + PhD thesis 2018

Instability of stratified boundary layers above an undulated tilted bottom

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Type of work: Experimental

Background

Our understanding of ocean and atmosphere dynamics is mainly based on the use of quasi-geostrophic models in which rapid and small-scale motions are filtered out. Although these balanced models provide in general a good description of slow and large-scale motions, they are unable to describe phenomena associated with internal waves, such as, for example, the flow induced at mid-atmosphere by internal wave breaking. It is also known that internal waves are essential in the energy budget of the ocean. Internal waves are observed in both the ocean and the atmosphere but their mechanisms of generation are still a source of debate. It is known that internal waves can be generated by direct forcing (interaction with topography, convection, barotropic instabilities) or by transient (geostrophic adjustement) but these sources are probably not the only sources.

Recently, we have shown numerically that the amplitude of these internal waves can diverge in a critical layer when they are forced by a tilted and undulated bottom. This creates a strong shear which may be unstable with respect to Kelvin-Helmholtz instabilities, possibly leading to a strongly turbulent flow. Such an instability (shown on Fig. 1) had already been observed for a tilted vortex in a stratified fluid for which the structure of the critical layer is strictly similar.

The objective of the master 2 project and of the PhD thesis is to visualise and characterize the critical layer and the instability experimentally using shadowgraph for different tilt angles, Reynolds numbers and Froude numbers. The impact of this instability in the ocean and atmosphere dynamics will then be addressed.

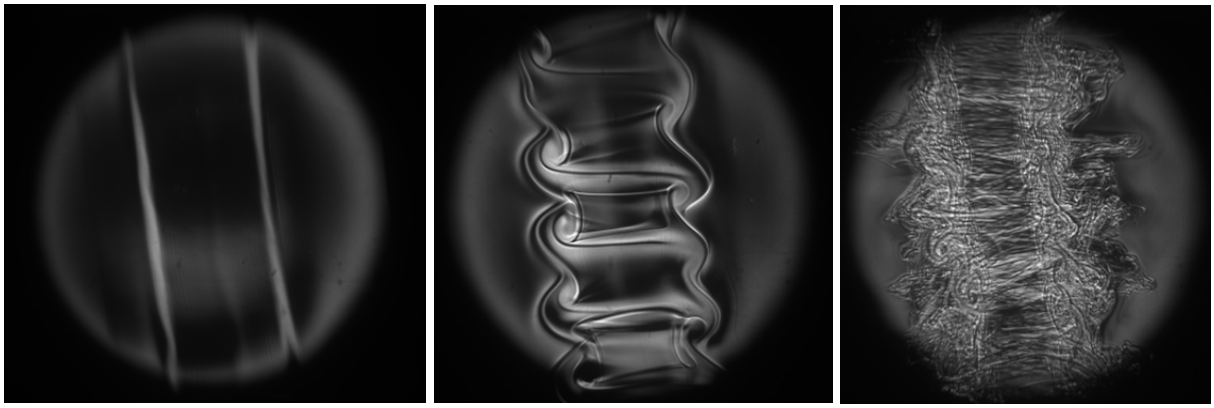

Figure 1: Experimental shadowgraph visualisation of the instability occurring in the critical layer of a vortex tilted in a stratified fluid.