Some key ingredients for observing an internal gravity waves turbulence regime

Vincent Labarre[1], Pierre Augier[2], Giorgio Krstulovic[1], et Sergey Nazarenko[3]

[1] Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, Nice, France
[2] Université Grenoble Alpes, CNRS, Grenoble INP, LEGI, Grenoble, France
[3] Université Côte d'Azur, CNRS, Institut de Physique de Nice - INPHYNI, Nice, France
`vincent.labarre@oca.eu`

Stratified flows support the propagation of internal gravity waves that interact non-linearly. The Wave Turbulence Theory (WWT) aims to describe the collective behavior of such waves systems, when the interactions are weakly non-linear [1,5,6,3]. Yet, the presence of shear modes, vortical modes [7], and wave-breaking [2] makes the observation of an internal gravity-waves turbulence regime in a realistic flow delicate, if not impossible.

We performed Direct Numerical Simulations of linearly stratified flows in a periodic domain, with and without vortical modes, using a pseudo-spectral solver [4]. We varied the values of the control parameters, namely the Froude and Reynolds numbers, in order to assess the existence of a wave turbulence regime.

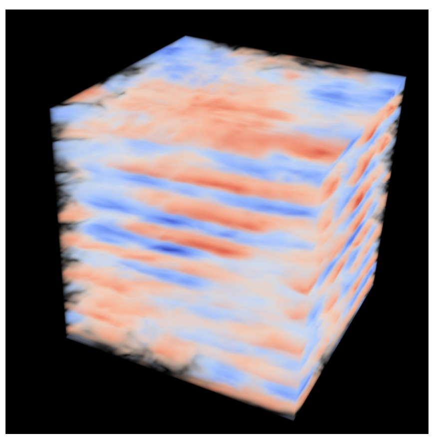

Figure 1. Buoyancy field of a strongly stratified flow without vortical modes.

We report that not only a strong stratification matters for observing internal gravity waves turbulence. (i) Keeping the aspect-ratio of the domain close to unity, (*ii*) having a scale separation between the eddy turnover time and the wave-period [8], and (*iii*) forcing at high frequency and small spatial scales are important as well. For more, vortical mode energy is never negligible when they are not removed from the dynamics. These results motivate the removing of the hydrostatic hypothesis when considering the problem of interactions between internal gravity waves.

References

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