REPORT OF THE MILESTONE EXPERIMENT: STRONGLY STRATIFIED TURBULENCE AND MIXING EFFICIENCY IN THE CORIOLIS PLATFORM

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Our understanding of the dynamics of turbulence strongly influenced by a stable density stratification has been deeply changed at the beginning of the 21st century. Studies based on large-resolution numerical simulations have shown that there is a strongly stratified regime associated with a downscale energy cascade [9, 6]. It has been understood that the stratified turbulence is characterised by two important non-dimensional numbers and that the regime called "strongly stratified turbulence" is obtained only for very small horizontal Froude number and large buoyancy Reynolds number [3, 4],

$$F_h = \frac{\varepsilon_K}{NU^2} \ll 1, \quad \mathcal{R} = \frac{\varepsilon_K}{\nu N^2} > 10, \tag{1}$$

where ε_K is the kinetic energy dissipation, N the Brunt-Väissälä frequency, U the root-mean-square horizontal velocity and ν the kinematic viscosity. Riley *et al.* [10] showed that strongly stratified turbulence is a possible interpretation for some geophysical turbulent measurements.

In a laboratory experiment, it is very difficult to fulfill the two conditions $F_h \ll 1$ and $\mathcal{R} > 10$ at the same time, since this requires very large facilities. Most of stratified flows studied experimentally correspond to a regime very different than strongly stratified geophysical flows [8, 2, 1]. Brethouwer *et al.* [5] and Maffioli *et al.* [7] investigated numerically the mixing produced by strongly stratified turbulence and showed that at very small horizontal Froude number ($F_h < 0.03$) and large buoyancy Reynolds number, the mixing efficiency tends to be independent of these parameters with a mixing coefficient $\Gamma = \varepsilon_A/\varepsilon_K$ of the order of 0.35, where ε_A and ε_K are the dissipation rates of available potential energy and kinetic energy, respectively. This value is nearly twice larger that the canonical value 0.2 used for mixing parametrization in oceanic models. Moreover, the effect of rotation on mixing efficiency of strongly stratified turbulence has to be investigated.

We present results of the EuHIT project experiment (called MILESTONE) dedicated to better understand these issues by careful measurements of strongly stratified turbulence in a large-scale experiment in the Coriolis platform.The flow is forced by a slow periodic movement of an array of six vertical cylinders of 25 cm diameter with a mesh of 75 cm. Five cameras are used for 3D-2C scanned horizontal particles image velocimetry (PIV) and stereo 2D vertical PIV. Five density-temperature probes are used to measure vertical and horizontal profiles and signals at fixed positions. The results indicate that we manage to produce strongly stratified turbulence at very small F_h (down to 8 10^{-3}) and large $\mathcal{R}$ (up to 70) in a laboratory experiment. We present first experimental results of the evolution of structure functions and of mixing efficiency as a function of F_h and $\mathcal{R}$ in this regime.

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