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Buoyant mixing modifications by Unstable Flows

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Turbulent mixing is an important issue in geophysical and Astrophysical phenomena. Diffusion of physical quantities is controlled by the mixing generated by turbulence as well as the dominant forcing mechanisms and fluid instabilities. The study of the turbulent mixing due to unstable gravitational forces is performed using a simple experimental model with two fluids of unequal density in a top heavy fashion. The mixing process is generated by the evolution of a bidimensional array of forced turbulent plumes that soon form a Rayleigh-Taylor instability front. The mixing efficiency and the volume of the final mixed layer are shown to be functions of the Atwood number, which ranges from 0.010 to 0.134. The mixing efficiency has an upper limit of 0.18 and this efficiency is about 20% of the maximum mixing efficiency (0.5) in comparable experiments. To understand this difference: the distribution of the array of plumes modify the overall mixing efficiency, so it depends strongly on initial conditions. The reduction of the overall mixing efficiency when the flow starts as an array of plumes may be explained because there is less volume where contact may exist at molecular level. The regions of higher local mixing would be the cones of the plumes - using Turners plume entrainment hypothesis-. More, the outer region of the cones-plumes will never contain heavier fluid so once the potential energy is lost by a falling plume no mixing may take place locally above the Ozmidov scale. This initial dilution and the horizontal entrainment affects in a non-linear fashion the overall mixing efficiency. To verify these hypothesis, we performed experiments with a line of plumes -from one to nine plumes- with an Atwood number of 0.03. Measurements of the height of the final mixed layer as functions of the number of plumes are made to verify that the less the number of plumes the lower the mixing efficiency. The behaviour of isolated plumes is also analysed comparing the 3D velocity spectra in the experiments as a

function of the Atwood number.

References

Gonzalez Nieto, P.L., 2004, PhD Thesis. Universidad Complutense, Madrid.

Linden P.F. & Redondo J.M. (1991) “Molecular mixing in Rayleigh-Taylor instability. Part 1. Global mixing”. Phys. Fluids. 5 (A), 1267-1274.

Linden P.F., Redondo J.M. and Youngs D. (1994) “Molecular mixing in Rayleigh-Taylor Instability” Jour. Fluid Mech. 265, 97-124.

Redondo J.M. and Linden P.F.(1990) Mixing produced by Rayleigh-Taylor instabilities Proceedings of Waves and Turbulence in stably stratified flows, IMA conference. Leeds 18 Dec 1989. Ed. S.D. Mobbs.

Sharp, D. H. (1984). An overview of Rayleigh-Taylor Instability, Physica 12D, 3.

Redondo, J.M. & Yague, C. (1995) Plume entrainment in stratifed fows Recent Research Advances in the Fluid, Mechanics of Turbulent Jets and Plumes , 209-222.