Lift off and turbidity currents in the environment

J.M. Redondo
Departament Fisica Aplicada, Universitat Politecnica de Catalunya, Spain.
redondo@fa.upc.edu

Abstract

This contribution presents an experimental investigation on the behaviour of sediments in a turbulent boundary layer flow, it compares the energy and vorticity needed to generate a turbidity current and the zero mean flow lift off and entrainment across a stably stratified density interface, either produced by solutes, sediment concentration or both. The experimental parameters are used to quantify the entrainment, the mixing efficiency and different types of dominant instability and the topological aspects of the turbulent cascade in the environment. The experiments allow to detected both horizontally and vertically [1,2] the local sediment and velocity fields. Grid turbulence in an enclosed two layer system is measured with PIV as well as with sonic velocimetry. Observations of the horizontal and vertical velocity energy spectra as well as the structure functions are used to estimate local mixedness, entrainment and intermittency [3,4]. The method of estimation of the average eddy diffusivity from the time series images of a sharp density interface marked by fluoresceine are also presented taking anisotropy into account. but on the long run, horizontal (and 2D type flow such as in [5]) flow directions will average out so using a single integral length scale, such as the one defined in Sanchez and Redondo(1998) varying in height will be enough together with the internal frequency. The method of calculating vertical fluxes in time allows to estimate different intermittency parameters as a function of local instability e.g. Kelvin/Helmholtz, Rayleigh-Taylor or Holbmoe[6-8]. Different concentration interfaces show different structures, that are also a power function of the local Richardson number, this may be due to different levels of intermittency and thus different spectra, which are not necessarily inertial nor in equilibrium.

Comparing Shields parameter on the one hand, and vertical entrainment is used to test the possibilities of a well known experimental configuration (oscillating grid mixing box), used to study stratified fluids in turbulent flows with zero-mean flows, also on the study of sediment transport, and to find out what are the critical effects of load and cohesivity of sediment layers.

Keywords: sediments, turbidity, entrainment, mixing, lift off.

References

[1] D. Crespo and J. M. Redondo, *A simple experiment on the interaction between gravity currents and sediment transport* . Rev. Geofisica, 45 : 203-210, 1989.

[2] G.V. Middleton, *Sediment deposition from turbidity currents*, Annu. Rev. Earth Planet . Sci. 21: 98-114, 1993.

[3] M.A. Sanchez and J.M. Redondo, *Observations from Grid Stirred Turbulence*, Applied Scientific Research 59, 191-204. 1998.

[4] J.M. Redondo and I.R. Cantalapiedra, *Mixing in Horizontally Heterogeneous Flows*, Applied Scientific Research 51: 217-222, 1993.

[5] R. Castilla, Redondo J.M., Gamez P.J., Babiano A., *Coherent vortices and Lagrangian Dynamics in 2D Turbulence* , Non-Linear Processes in Geophysics 14: 139-151. 2007.

[6] J.M. Redondo, *Mixing efficiencies of different kinds of turbulent processes and instabilities, Applications to the environment*, Turbulent mixing in geophysical flows. Eds. Linden P.F. and Redondo J.M. 131-157. 2002.

[7] J.M. Redodo, *Turbulent mixing in the Atmosphere and Ocean* ,Fluid Physics. 5: 584-597.World Scientific. New York. 1994.

[8] O.B. Mahjoub, Redondo J.M. and Babiano A. *Structure functions in complex flows*, Journal of Flow Turbulence and Combustion 59: 299-313., 1997.