Geophysical Research Abstracts, Vol. 8, 08508, 2006
SRef-ID: 1607-7962/gra/EGU06-A-08508

The structure of environmental turbulence: the spectra of jets and vortices

E. Sekula, **A. Matulka**, O.B. Mahjoub, J. M. Redondo

Departamento de Física Aplicada, Universitat Politecnica de Catalunya, Barcelona, Spain (emil_sekula@op.pl / Fax. +34 93 4016090 / Phone: +34 605720488) (ania@matulka.net / Fax. +34 93 4016090 / Phone: +34 645194717) (otman@fa.upc.edu / Fax. +34 93 4016090 / Phone: +34 649382974) (redondo@fa.upc.edu / Fax: +34 93 4016090 / Phone: +34 93 4017984)

The main aim of this research is to understand and describe key aspects of the structure of non-homogeneous turbulence affected by stratification and rotation, in particular turbulent jets and plumes and their interaction with coherent structures such as vortices. Other effects connected with non-homogeneity (for example boundary layer - jet interactions) are presented. Most predictive models fail when forcing at the Rossby deformation Radius is important and a large range of scales have to be taken into account. When mixing of reactants or pollutants has to be accounted, the range of scales spans from hundreds of kilometers to the Bachelor or Kolmogorov sub millimeter scales. Effect of intermittent eddies and non-homogeneity of diffusion is also issues in the environment because both stratification and rotation body forces are important and cause anisotropy/non-homogeneity. These problems need further approaches and we maximize the relevant geometrical fractal information in order to understand and therefore predict these complex environmental dispersive flows. The present work is based principally on laboratory experiments producing turbulence by means of jets and wakes. We compare the different series of detailed experiments that have been performed in the Laboratory of Fluid Dynamics of the UPC on jet and wake generated turbulence and its decay. Measurements of the 3 components of turbulent velocity and their spectra are presented in order to obtain a basic understanding on local diffusion, mixing and mass transport in jets and vortices. We compare different wall and boundary effects on the structure of jets and vortices including vorticity production and decay. We present ADV velocity measurements and compare mean and fluctuating velocity components as well as their PDF's and spectra. The turbulent interactions

between the jets, vortices and the boundary layer structures generated are discussed taking into account both the inverse and direct cascades of the jets as a function of their distance to the wall. Another series of experiments have been performed on a strongly stratified two layer fluid consisting of brine in the bottom and freshwater above in a 1 square meter tank. The evolution of the vortices after the passage of an array is video recorded and particle tracking is applied on small pliolite particles floating at the interface. The combination of internal waves and vertical vorticity produces separate time scales that may produce resonances.

These complex non homogeneous structures occur in many industrial and environmental applications and elucidating their structure will be useful for better estimates of entrainment and mixing efficiency. The importance of the study of turbulence structure and its relevance in diffusion of contaminants in environmental flows self-similarity is present with very few exceptions in most environmental strongly non-homogeneous flows, both vertically and horizontally. Using the concept of Extended Self Similarity (ESS) we describe a criterion to identify the inertial range in the Kolmogorov sense as well as a methodology based on the evaluation of the spectral behavior and the structure functions of the velocity fields to determine intermittency. The statistical description of these complex environmental turbulent systems (jets and vertical structures) is performed in the framework of ESS for non-homogeneous turbulence based on the analysis of the energy transfer hierarchy. A physical interpretation of the scale independence of the relative exponents indicates the non-homogeneity of the turbulent field, which is characterized by non-local dynamics and not only intermittency. Determining the spectral structure of the turbulence cascade and the higher order structure functions helps to determine mixing properties and relationships between these kinds of structures.