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Velocity and Vorticity Fields of a Turbulent Plume under different experimental conditions

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The geophysical and practical importance and the applications of turbulent plumes as generators of strong dispersion processes are clearly recognized. In geophysics and astrophysics, it is usual to model as a jet or plume the generation mechanism of turbulent mixing as a part of a dispersion process [1-3]. An interesting geophysical problem is the study of volcanic plumes [2], which are columns of hot volcanic ash and gas emitted into the atmosphere during an explosive volcanic eruption. Another interesting like-plume phenomenon can be observed where a stream, usually a river, empties into a lake, sea or ocean, generating a river plume [3,4].
Turbulent plumes are fluid motions whose primary source of kinetic energy and momentum flux is due to body forces that arise from density inhomogeneities. The plume boundary acts as an interface across which ambient fluid is entrained, and the plume boundary moves at the velocity of the plume fluid. The difference between the plume-fluid radial velocity and the total fluid velocity quantifies in a natural way the purely horizontal entrainment flux of ambient fluid into the plume across the phase boundary at the plume edge [5,6].
We show some results of research on a single turbulent plume as well as on the structure of the interaction between different plumes and jets, We measure and compare velocity and vorticity fields occurring in different experimental configurations (Parametrized by the Atwood number and the initial potential energy as well as the Plume-Jet length scale). This work is based on experiments that have been performed in GFD laboratories (IPD and UPC) using visualizations methods (LIF,PIV) and advanced multiscaling techniques.
We calculate velocity and vorticity PDFs and the evolution of the structure of stratified decaying, with DigFlow and Imacalc programs (Matulka 2010)[7], where video sequence processing provides a range of global and local descriptor features designed specifically for analysing fluid flows and turbulent structure. The main aim of the research in particular is to investigate mixing processes and their efficiency for different turbulent plumes, jets and their scale to scale reactions with dominant coherent structures such as vortices. The interesting way to analyse fith multifractal [8,9] techniques the evolution of contours comparing scalar, velocity and vorticity interfaces to visualize in different parameter and phase spaces that give us an idea on local mixing influenced by velocity, vorticity and helicity for different Atwood numbers in time.

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