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Geophysical Research Abstracts
Vol. 13, EGU2011-13341, 2011
EGU General Assembly 2011
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Time Evolution of the Fractal Dimension in Turbulent Plumes

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Turbulent mixing is a very important issue in the study of geophysical phenomena because most fluxes arising in geophysics fluids are turbulent. We study turbulent mixing due to convection using a laboratory experimental model with two miscible fluids of different density with an initial top heavy density distribution. The fluids that form the initial unstable stratification are miscible and the turbulence will produce molecular mixing. The denser fluid comes into the lighter fluid layer and it generates several forced plumes which are gravitationally unstable. As the turbulent plumes develop, the denser fluid comes into contact with the lighter fluid layer and the mixing process grows. Their development is caused by the lateral interaction between these plumes at the complex fractal surface between the dense and light fluids.
Fractal studies provide a natural method for analyzing turbulent fields like plumes and their turbulent cascade processes. If there is a subrange where production and dissipation are at equilibrium, it is possible a functional relation between the exponent b of the spectral density function and the fractal dimension D of the scalar field represented in the images: beta=2EU+1-2D, where EU is the euclidian dimension.
The last aim is to investigate the intermittency of the mixing plumes (measuring the maximum fractal dimension and using results of another researchers relating to the sixth and third order structure function scaling exponents).
We investigate the fractal structure of non homogeneous plumes affected by different levels of buoyancy (different values of the Atwood number (A) and by the initial potential energy (several initial heights Ho of the source). We analyse the time evolution of the fractal dimension as plumes develop and we make a multifractal analysis. This fractal and multifractal analysis of the turbulent convective plume was performed with the box counting algorithm for different intensities of evolving plume images using a special software.

We acknowledge the help of Prof. M. García Velarde and the facilities offered by the Pluri-Disciplinary Institute of the Complutense University of Madrid. We also acknowledge the help of European Community under project Multi-scale complex fluid flows and interfacial phenomena (PITN-GA-2008-214919). Thanks are also due to ERCOFTAC (PELNoT, SIG 14)

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