Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07273, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07273
EGU General Assembly 2008

Multi-fractal analysis of direct and inverse cascades in turbulent jets and fronts; laboratory and field observations

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Experimental and Geophysical observations are investigated with multi-scale techniques in order to extract relevant information on the spectral characteristics of mixing and diffusive events. Both density and tracer marked interfaces are investigated in several experimental configurations where different tracers are diffused by means of unstable Jets [1]. Both plane and vertical configurations are used, where the initial density difference is characterized by the Atwood number. The evolution of the Jets or the Rayleigh-Taylor (RT) instability fronts, generates a combination of spikes and bubbles, which reach maximum complexity and local mixing efficiency before the front reaches the end walls. The diffusion of oil spills, slicks or vertical structures in the ocean are also investigated using the same multi-fractal techniques developed by Grau (2005) [3]. Both cases are studied analyzing mixedness, [2], ESS and the third order structure functions, that indicate strong inverse cascades towards the large scales producing spectral variations [4]. The mixing processes are compared by mapping the different intermittency (Obtained by relating it to the sixth and third order structure function scaling exponents and to the measured maximum Fractal dimension) and the multi-fractal scaling. Several uses of this new technique are proposed [5] taking advantage of Zipf's Law, maximizing the additional spectral information from remote sensing so that different areas dominated by buoyancy, momentum or vorticity cascades may be identified following the analysis presented in [6].

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