Geophysical Research Abstracts
Vol. 16, EGU2014-4702, 2014
EGU General Assembly 2014

Lagrangian statistics in laboratory 2D turbulence

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Turbulent mixing in liquids and gases is ubiquitous in nature and industrial flows. Understanding statistical properties of Lagrangian trajectories in turbulence is crucial for a range of problems such as spreading of plankton in the ocean, transport of pollutants, etc. Oceanic data on trajectories of the free-drifting instruments, indicate that the trajectory statistics can often be described by a Lagrangian integral scale. Turbulence however is a state of a flow dominated by a hierarchy of scales, and it is not clear which of these scales mostly affect particle dispersion. Moreover, coherent structures often coexist with turbulence in laboratory experiments [1]. The effect of coherent structures on particle dispersion in turbulent flows is not well understood. Recent progress in scientific imaging and computational power made it possible to tackle this problem experimentally.

In this talk, we report the analysis of the higher order Lagrangian statistics in laboratory two-dimensional turbulence. Our results show that fluid particle dispersion is diffusive and it is determined by a single measurable Lagrangian scale related to the forcing scale [2]. Higher order moments of the particle dispersion show strong self-similarity in fully developed turbulence [3]. Here we introduce a new dispersion law that describes single particle dispersion during the turbulence development [4]. These results offer a new way of predicting dispersion in turbulent flows in which one of the low energy scales are persistent. It may help better understanding of drifter Lagrangian statistics in the regions of the ocean where small scale coherent eddies are present [5].

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