Abstract Submitted
for the DFD06 Meeting of
The American Physical Society

Studying a stochastic turbulence model for Lagrangian dynamics of the velocity gradient tensor using direct numerical simulation[1]
CHARLES MENEVEAU, LAURENT CHEVILLARD, Johns Hopkins University, LUCA BIFERALE, Univ. Tor Vergata, Rome, Italy, FEDERICO TOSCHI, IAC-CNR, Rome, Italy — A new stochastic Lagrangian model for the evolution of the velocity gradient tensor in turbulent flow has been recently developed (Chevillard & Meneveau, 2006). It includes closures for the pressure and velocity gradient Hessians based on the local deformation field seen by a fluid particle along its trajectory. The model yields statistically stationary statistics and reproduces several well-known properties of turbulent flows, such as alignments of vorticity, joint pdfs in the R-Q plane, as well as anomalous relative scaling of moments of the velocity gradient at moderate Reynolds numbers. In this talk, model predictions for the various model terms are compared in detail with results from DNS at various Reynolds numbers. In order to quantify trends in relation to local topology, conditional averages at fixed values of R and Q are used. We conclude that the model reproduces the dynamics quite well in strain-dominated regions, but shows qualitative differences in regions dominated by rotation and vortex-stretching. We speculate on possible effects of coherent small-scale vortex structures.

[1]Supported by: Keck Foundation, Center for Environmental and Applied Fluid Mechanics (JHU), NSF (ITR-0428325) and CNR Short Term Mobility Program 2006.

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Date submitted: 04 Aug 2006 Electronic form version 1.4