Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Advection, diffusion & dispersion: effective diffusion for transient mixing vs. stirring with steady sources & sinks[1] CHARLES R. DOERING, ZHI LIN, University of Michigan — The effective diffusion coefficient κ_{eff} of a flow is often defined in terms of passive tracer particle dispersion. For some high Péclet number flows κ_{eff} may be as large as $\kappa_{molec} \times Pe^2$ where κ_{molec} is the molecular diffusion coefficient and the Péclet number $Pe = U\ell/\kappa_{molec}$ is defined in terms of characteristic velocity (U) and length (ℓ) scales in the flow. On the other hand for stirring in the presence of steady sources and sinks an equivalent diffusion coefficient κ_{eq} may be defined in terms of (statistical steady state) passive scalar concentration variance suppression. A theorem states that $\kappa_{eq} \leq \kappa_{molec} \times Pe \times (L/\ell)$ as $Pe \to \infty$ where L is a characteristic length scale of the sources-sink distribution. We discuss the origin and resolution of this discrepancy: effective diffusion coefficients proportional to Pe^2 arise in the large time asymptotic limit of particle dispersion while equivalent diffusion coefficients defined by concentration variance suppression for scalars sustained by steady sources are dominated by short-time transport characteristics of the flow. The theories may be reconciled by considering a time dependent effective diffusion coefficient that includes the transient—and not just time asymptotic—tracer particle dispersion.

[1]Supported by NSF-PHY0555324

Charles R. Doering
University of Michigan

Date submitted: 04 Aug 2008 Electronic form version 1.4