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Relative dispersion of passive scalar plume in a turbulent boundary layer QIAN LIAO, Dept. of Civil Eng. and Mech., Univ. of Wisconsin-Milwaukee, EDWIN COWEN, Defrees Hydraulics Laboratory, Cornell Univ. — Recent studies on relative dispersion have been exclusively focused on statistics of particle pair separation. Less attention was paid to its application in dispersing contaminant plumes or puffs. Since introduced by Richardson (1926), distance-neighbor function has been used to characterize the detail structure of concentration field in a dispersing cloud. Its evolution was described by a diffusion equation (Batchelor, 1952), where the diffusivity is proportional to the four-third power of the separation length. The present experimental study provided an evidence for this hypothesis. A passive fluorescent tracer is continuously released from a flush-bed mounted source into the turbulent boundary layer of a laboratory open channel flow. A two-dimensional Particle Image Velocimetry - Laser Induced Florescence (PIV-LIF) technique is applied to measure the instantaneous horizontal velocity-concentration field. Assuming one-dimensionality, the distance-neighbor function is calculated as the lateral auto-correlation of concentration distribution. Thus the relative diffusivity can be directly calculated from the streamwise evolution of the distance-neighbor function. The relative diffusivity is found to be dependent on the instantaneous separation, and can be described by a 4/3 power law in the inertial sub-range. The Richardson-Obukhov constant is also determined from experimental results. An extended model for relative diffusivity is provided based on the structure of turbulent velocity field and it agrees with measurements excellently.

Qian Liao
Department of Civil Engineering and Mechanics
University of Wisconsin-Milwaukee, Milwaukee, Wisconsin WI

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