1.061 / 1.61 Transport Processes in the Environment
Fall 2008

1.061/1.61: Homework # 5 [10 pt total]

Problem 1 [5 pts]
Consider a fluid system with a linear distribution of concentration, $C(y) = C_0 - by$. Turbulent energy is added to the system through an array of mechanical mixers which produces turbulent fluctuations (u', v', w') and eddy scales (lx, ly, lz) which are homogeneous and isotropic. Make a set of four graphs, one for each of the following quantities.

a) magnitude of turbulent fluctuation v'
b) turbulence length scale, ly
c) turbulence correlation $\overline{v'C'}$
d) turbulent diffusivity $D_y(y)$

On each graph compare the following two cases.

Case 1. The system is completely unbounded.
Case 2. A solid boundary exists at $y = 0$.

Problem 2 [5 pts]
Consider a river that is h = 2.0-m deep and b = 10-m wide. The flow, $U = 1.0$ ms^{-1}, is spatially uniform. As part of a nutrient enrichment study you will release a slug of nutrient rich water into the stream using a discharge of 2.0 gs^{-1} that is left on for 10s. The discharge will be at mid-depth and against the bank (x = 0, y = 0, z = h/2). The side walls, bed, and water surface are all no-flux boundaries. The turbulent diffusion in the river is homogeneous but anisotropic: $D_x = 1$ m^{2}s^{-1}, $D_y = 0.1$ m^{2}s^{-1}, and $D_z = 0.05$ m^{2}s^{-1}. You are interested in two particular field sites located downstream at L1 = 500m and L2 = 2000m.

a) Write an expression in variable form that describes the concentration at each site. Clearly state and justify each assumption. Include a sketch that defines the coordinate system.
b) What is the peak concentration experienced at each site?

GRADUATE STUDENTS ONLY - DUE December 4, 2002.
Begin by reading the following three articles. Then find an additional related article, preferably a more recent article, e.g. using the Web of Science citation search. Compare and summarize the articles in **no more than 2 pages of prose**.

Lawrence, G. 1995. Natural dispersion in a small lake. *Limnol. Oceanogr.*, **40**(8): p. 1519.

Okubo, A. 1971. Oceanic diffusion diagrams. *Deep-Sea Research*. **18**:789-802.

Ledwell J, Watson A, Law C., 1998. Mixing of a tracer in the pycnocline. JOURNAL OF GEOPHYSICAL RESEARCH-OCEANS **103** (C10): 21499-21529.