

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

DUE October 21, 2002

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 (l_x , l_y , l_z) which are homogeneous and isotropic. Make a set of four graphs, one for each of the following quantities.

- magnitude of turbulent fluctuation v'
- turbulence length scale, l_y
- turbulence correlation $\overline{v' C'}$
- 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, $U = 1.0 \text{ ms}^{-1}$, 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: $D_x = 1 \text{ m}^2\text{s}^{-1}$, $D_y = 0.1 \text{ m}^2\text{s}^{-1}$, and $D_z = 0.05 \text{ m}^2\text{s}^{-1}$. You are interested in two particular field sites located downstream at $L1 = 500\text{m}$ and $L2 = 2000\text{m}$.

- 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.
- 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.