HOMEWORK #1

1. You have been tasked with monitoring a near-seabed diffuser from a local sewage facility. To do so, you deployed two current meters: one near the diffuser, to measure the flux out of it; the other one away from it, to monitor near-bed ambient currents. However, when you retrieve the probes, you realize that the labels were worn off and you forgot which probe corresponds to each deployment location. All of you have is the data (hw1.txt, in this directory).

    a. Which probe was near the diffuser?
    b. How can you tell?

2. For uniform, steady flow in a wide rectangular channel the velocity profile may be estimated from knowledge of the bottom shear stress, the equivalent bottom roughness, and an assumed turbulent eddy viscosity model.

Consider the following turbulent eddy viscosity models:

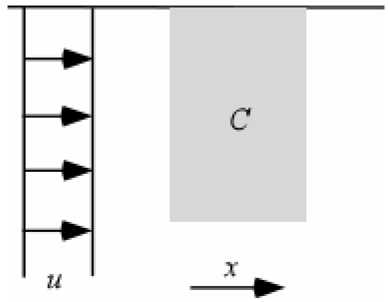
(1) $$\nu_T = \kappa u_* z \qquad 0 \le z < h$$

(2) $$\nu_T = \kappa u_* z\left(1 - \frac{z}{h}\right) \qquad 0 \le z < h$$

in which $\kappa = 0.4$ is von Karman's constant, $u_* = \sqrt{\tau_0/\rho}$ is the shear velocity, and z is the coordinate perpendicular to the bed.

a) For each of the eddy viscosity models given derive under the assumption of fully rough turbulent flows (i.e., assume no-slip at $z=z_0<<h$), the expression for the velocity profile in a uniform steady flow in a wide rectangular channel (i.e., 1-D boundary layer).
b) Discuss the differences between the velocity profiles derived in (a). In particular comment on the significance of these differences and therefore on the importance of the particular choice of eddy viscosity model if u_* is assumed to be of the order 5% of the velocity at $z=h$.
c) What are the practical implications of the above results in terms of using measured velocity profiles to establish an eddy viscosity model?

3. Consider a uniform patch of plankton (settling velocity, $w_s \sim 0$) in a turbulent, uniform oceanic current. You can show that the concentration with time will obey the following conservation equation –



$$\frac{\partial C}{\partial t} + \frac{\partial (uC)}{\partial x} = 0$$

Where *u* is the mean velocity, *C* is the concentration of plankton

a. Reynolds-average the equation.
b. Explain the physical meaning of each term in the final Reynolds-averaged equation.
c. What should happen to a patch of plankton over time?