SMS-618, Particle Dynamics, Fall 2003 (E. Boss)

Assignments 3 (use Hill and McCave, 2001, and attached m-file):

Taylor and Dyer (1977) derive a solution for both velocity and sediment based on the stability parameter (denoting by $A = \beta z/L$, with β=*5.2*) and Rouse number, $R_n = w_{sn}/\kappa u_*$ and for small roughness length scale z_0:

$$\ln\left(\frac{C(z)}{C_0}\right) = -R_n\left[\ln\frac{z}{z_0} + \frac{1}{R_n}\ln\left\{1 + \frac{AR_n}{(1-R_n)}\left[\left(\frac{z}{z_0}\right)^{1-R_n} - 1\right]\right\}\right]$$

$$u(z) = \frac{u_*}{\kappa}\left(\ln\frac{z}{z_0} + \frac{1}{R_n}\ln\left\{1 + \frac{AR_n}{(1-R_n)}\left[\left(\frac{z}{z_0}\right)^{1-R_n} - 1\right]\right\}\right)$$

1. Using Taylor and Dyer (1977) formulas, compute the velocity and suspended sediment profiles (for C/C_0, u/u_* and $\kappa Cu/(C_0u_*)$, as function of $10000>z/z_0>1$) for the following 4 cases:

   1. Moderate flow with fine sand (200μm) over a rippled sand or sandy gravel bed. u_*=4cm s^{-1}, w_s=2.25 cm s^{-1}, z_0=1cm and c_0=0.1. → R_n =1.4 and A=5.0.
   2. For the same parameters but with u_*=10cm s^{-1}→R_n=0.56 and A=0.32.
   3. For coarse silt (60μm) with u_*=4cm s^{-1}, w_s=0.32 cm s^{-1}, z_0=0.1cm and c_0=0.14. → R_n=0.2 and A=0.1.
   4. For values similar to case 3, apart from z_0=0.001cm, R_n=0.2 and A=0.001.

2. How are the profiles different (look in real space as well as in log space)? Which transport the most material? Which the least? Is it consistent with the value of u_*, and or the value of the Rouse number (remember, the smaller the Rouse number the smaller is the ratio of sinking to resuspension)?

3. Where do these examples fall within Fig. 4.5 of Hill and McCave (2001)?

4. What happens when $A=(1-R_n)/R_n$? When z/L=0.03? When R_n >3?

5. 5. How do the sediments profile compare (qualitatively) with other solutions discussed in class such as:

$$\frac{\overline{C}(z)}{\overline{C}(z_0)} = \left(\frac{z}{z_0}\right)^{-R/\alpha} \quad \text{or} \quad \frac{\overline{C}(z)}{\overline{C}(z_0)} = \exp\left\{-\frac{R(z-z_0)}{\alpha H_{BBL}}\right\}$$