METR 130: Take-Home Assignment for Exam #2 (Spring 2011)
Due Date: March 24, 2011

Question 1: A relationship for the concentration (C) of a surface air pollution release as a function of downwind distance from of the release (x) is as follows:

$C(x) = Q/(4\pi K_h x)$,

where

- Q is the release rate (grams per second)
- K_h is the turbulent diffusivity (meters-squared per second)

Assuming Q = 1 g/sec, evaluate the concentration 500 meters downwind of the release.

Evaluate for three cases neutral, stable and unstable conditions (note, that K_h depends on stability via Monin-Obukhov theory, see equations in notes and Arya text). Choose values of stability parameter z_{ref}/L that you judge typical for stable and unstable conditions (i.e. you don't have to calculate L to calculate z_{ref}/L).

Let the ten-meter wind speed (U_{ref}) equal 15 mph in all cases. Let $z_{0m} = 0.1$.

After getting concentration values for each of the three cases, compare to a given level of concern of C_{LOC} = 100 μg/m3. In which case(s) are your computed concentrations greater than this level of concern? Also, comment on whether your computer concentrations qualitatively make sense in terms of their relative value (i.e. which is highest vs. which is lowest).

Question 2: For wind erosion, a common empirical expression for the emission rate Q (in g/m^3) of dust/soil is

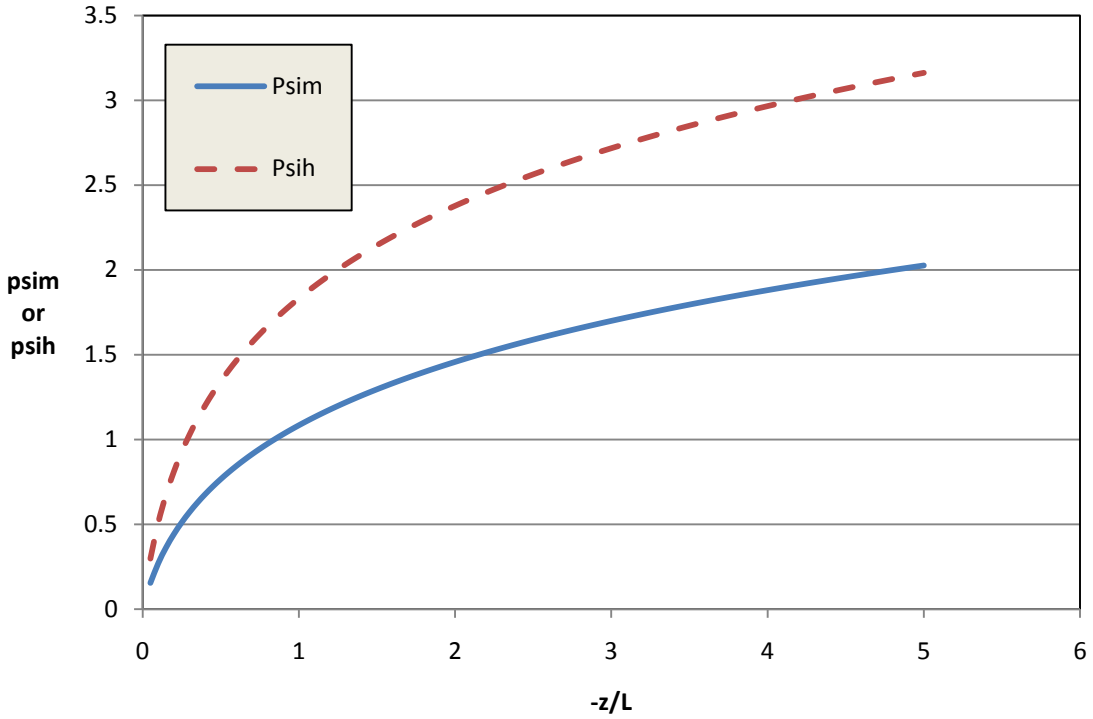
$Q = \alpha u_*^3(u_*-u_{*t}) \times A$

Where u_{*t} is a "threshold" friction velocity below which wind erosion does not take place (this threshold value depends on soil conditions), $\alpha = 0.0012\ gs^3/m^6$, and A is the area of the release.

Recalculate your answers to Question 1 using this expression to obtain different values for Q for each of your three cases (neutral, stable and unstable; values are different because u_* is different for each case). Assume $u_{*t} = 0.3$ m/s and A = 10,000 m^2.

Comment on how your results change from what you obtained in Question 1. Do this in terms of both which concentration values are now above C_{LOC} and how each changed relative to what was calculated in Question 1. Which case now produces the highest and lowest concentrations?

A Handy Graph to Calculate φ in unstable conditions



About Wind Erosion (see http://milford.nserl.purdue.edu/weppdocs/overview/wndersn.html)