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1.020 Ecology II: Engineering for Sustainability
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MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Civil and Environmental Engineering

1.020 Ecology II: Engineering for Sustainability

Problem Set 5 – Particulate transport
Due: 5PM Weds. April 16, 2008

A. Introduction

In this problem set you will be simulating particulate emissions from a single vehicle moving along a straight road with a cross wind. You will develop a particle tracking model to visualize the particulate plume and to compute atmospheric concentrations.

B. Vehicle Description

The road in question extends along the x axis for 120 km.

The vehicle is moving at 60 km hr^{-1}

Particulate emissions are generated continuously at a rate of $E = 2 \text{ gm min}^{-1}$.

A wind is blowing towards the $+y$ direction at $V_y = 30 \text{ km hr}^{-1}$.

The x and y dispersivities are: $D_x = D_y = 25 \text{ km}^2 \text{ hr}^{-1}$

Simulation time = 2 hr.

D. Problem Set Tasks

***** All of the information requested below should be compiled in a single MS Word (or equivalent) file with all your team member names clearly identified in the file name and submitted via the 1.020 Stellar site *****

Construct your own two dimensional (2D) MATLAB model for this problem.

Your model should do the following:

- 1. Compute x and y coordinates for a number of particles emitted from the moving vehicle over each time step. You should select reasonable values for the number of particles emitted and the time step duration to balance the realism of the results with the computation time.**
- 2. Determine the common mass value m of emissions represented by each particle.**
- 3. Display the particle locations at each time step with a 2D scatterplot movie. Include the final frame of the movie with your Stellar submission.**
- 4. Compute the concentration (in parts per billion) at the end of the simulation time in a bin at a location of your choosing.**

Be sure to select a bin size that is large enough to contain many particles but is small enough to give a reasonably local value. Be sure to place the bin at a location where there are particles. For calculating the concentration assume that the particle plume extends vertically 50 m. above the ground.

- 5. Provide a copy of the MATLAB code you used to generate your results.**