

Today, we will:

- Continue discussing the Gaussian plume model – prediction of hazardous area downwind of a plume, what to do about temperature inversions and fumigating plumes

Example: Gaussian plume

Given: A buoyant plume emitting air pollution, under the following conditions:

- Stack height = 80 m
- Buoyant plume rise = 40 m above stack exit
- Clear summer day with Sun high in the sky (early afternoon)
- The ground reflects (does not absorb) the air pollutant
- Average wind speed = 5.5 m/s
- The stack emits the air pollutant at a rate of 110 g/s

To do: Calculate the downwind location that has the maximum ground concentration.

Solution:

- First, use **Table 20.1** to determine the atmospheric stability class:
At $U = 5.5$ m/s in the daytime with strong incoming solar radiation, this is **Class C**.
- Next, use **Table 20.2** to obtain the coefficients for calculation of dispersion coefficients:
For Class C, we have $a = 104$, $b = 0.894$, $c = 61.0$, $d = 0.911$, and $f = 0$.

- At a given x location, calculate the dispersion coefficients:

$$\sigma_y = ax^b, \quad \sigma_z = cx^d + f, \quad \text{with } x \text{ in units of km and } \sigma_y \text{ and } \sigma_z \text{ in units of m.}$$

- The effective stack height is $H = h_s + \delta h = 80 + 40 = 120$ m.
- Use the reflecting ground Gaussian plume equation at $y = 0$ (centerline) and $z = 0$ (ground) to calculate the maximum ground concentration at various values of x :

$$c_j = \frac{\dot{m}_{j,s}}{2\pi U \sigma_y \sigma_z} \left[\exp \left\{ -\frac{1}{2} \left[\left(\frac{y}{\sigma_y} \right)^2 + \left(\frac{z-H}{\sigma_z} \right)^2 \right] \right\} + \exp \left\{ -\frac{1}{2} \left[\left(\frac{y}{\sigma_y} \right)^2 + \left(\frac{z+H}{\sigma_z} \right)^2 \right] \right\} \right]$$

Table to be filled in during class: Note: $U = 5.5$ m/s, $H = 120$ m, and $\dot{m}_{j,s} = 110$ g/s.

x (km)	c_j ($\mu\text{g}/\text{m}^3$)
0.4	
0.6	
0.8	
1.0	
1.2	
1.4	
1.6	
1.8	

x (km)	c_j ($\mu\text{g}/\text{m}^3$)
2.0	
2.2	
2.4	
2.6	
2.8	
3.0	
3.2	
3.4	