DISPERSION MODELING OF GROUND-LEVEL AREA SOURCES OF PARTICULATE

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Abstract

The modeling of air pollution dispersion is becoming increasingly more important to the regulatory process. With the passage of a new more stringent set of National Ambient Air Quality Standards, sources are going to be more heavily regulated. In addition, regulation of fugitive sources will be more emphasized than they have been historically. Dispersion models that provide accurate estimations of downwind concentrations of pollutant from fugitive sources are needed to insure reliable and fair regulation of these sources. Presently accepted Gaussian based models inaccurately apply time averages to calculated concentrations, and use dispersion profiles that do not accurately describe dispersion of pollutants from ground-level sources. These models apply a one-hour time period to a concentration that is referenced in literature as and is commonly accepted as a ten minute concentration. This results in a one-hour concentration that is excessively high. This "one-hour" concentration, in effect, assumes that a single wind speed and wind direction exist for the entire time period. This is inappropriate. A new model is being developed that accounts for the meteorological variation over smaller time increments, which results in predicted concentrations that are appropriate for the modeled time period. The new model also applies a dispersion profile that more accurately reflects dispersion from ground-level releases. The result is a model that more accurately predicts concentrations downwind of ground-level sources.

Introduction

The purpose of State Air Pollution Regulatory Agencies (SAPRAs) is insure that the safety of the public. This is accomplished through the regulation of sources emitting airborne pollutants. These sources are regulated based on set levels for specific pollutants as defined by the National Ambient Air Quality Standards (NAAQS). These are health based standards that define criteria pollutants and the maximum allowed ambient concentrations for each. The SAPRAs must determine whether or not pollutant release from a source results in overexposure to the public based on levels set by te NAAQS. One of the tools used by SAPRA engineers for this purpose, is dispersion modeling. Dispersion modeling is a mathematical tool that estimates downwind concentrations of pollutants as a function of the source emission rate, and on the meteorological conditions at the time of release. Based on results from dispersion modeling estimates, a source may be required to provide additional controls to further limit the amount of pollutant that they emit.

The use of dispersion modeling in the regulatory process is increasing. SAPRAs utilizing these modeling tools are required to use models that are approved by the U.S. Environmental Protection Agency (US EPA). The EPA recommended dispersion model is Industrial Source Complex (ISC) which is based upon the Gaussian Model. The current ISC models being used by SAPRAs are: ISC-ST3 (short term 3rd update), ISC-SCREEN3 which is a simple version of ISC-ST3 with imbedded meteorological data. These models are inaccurate. Downwind concentrations are over-estimated as a result of time periods inaccurately applied to calculated concentrations, and the use dispersion profiles that do not accurately describe dispersion of pollutants from ground-level sources.

These models apply a one hour time period to a concentration that is referenced in literature as a ten minute concentration. This results in one hour concentrations that is overly high. This "one hour" concentration, in effect, assumes one wind speed and one wind direction for the entire time period. This is inappropriate. For ground-level sources of pollutant, the dispersion profiles that describe the dispersion in the vertical plane is not appropriate. The vertical distribution, as used by the ISC models, disperses half of the pollutant into the ground and "reflects" it back into the plume. This results in a maximum concentration "spike" at ground level. The compounding of these errors produces an extreme over-estimation in the one hour concentration, and subsequently the 24 hour concentration.

Sources regulated based on models that provide over-estimates of the downwind concentrations are subject to unfair and unneeded financial strains. A source can potentially be required to install additional, expensive control devices as a result of a inappropriately estimated downwind concentration that indicates that the source is in violation of the NAAQS. The goal of this research is to provide a model for use by the regulatory agencies that accurately estimates downwind concentrations, and provides a fair basis for regulation of pollutant sources.

Discussion

The Gaussian Dispersion Model

An explanation of the Gaussian Dispersion model warranted at this point. Equation 1 is used to calculate the ambient downwind concentration associated with Gaussian dispersion from a pollutant source (Cooper and Alley, 1994):

$$C = \frac{Q}{2\pi u \sigma_y \sigma_z} \exp\left(-\frac{1}{2}\frac{y^2}{\sigma_y^2}\right)\left\{\exp\left(-\frac{1}{2}\frac{(z-H)^2}{\sigma_z^2}\right) + \exp\left(-\frac{1}{2}\frac{(z+H)^2}{\sigma_z^2}\right)\right\} \quad \text{(Eq. 1)}$$

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where

C = steady state concentration ($\mu g/m^3$),
Q = emission rate ($\mu g/s$),
π = 3.141593,
u = wind speed at stack height(m/s),
σ_y = lateral dispersion parameter (m),
σ_z = vertical dispersion parameter (m),
z = receptor height above ground (m),
H = plume centerline height (m).

A more detailed analysis of the Gaussian model will help in understanding how the model functions. As Figure 1 Illustrates, the Gaussian model consists of two components (Turner, 1994): density functions that relate area percentages for the horizontal direction, as shown by Equation 2.

$$f(y) = \frac{1}{\sigma_y \sqrt{2\pi}} exp\left(-\frac{y^2}{2\sigma_y^2}\right) \quad \text{(Eq. 2)}$$

and for the vertical direction, as shown by Equation 3.

$$f(z) = \frac{1}{\sigma_z \sqrt{2\pi}} \left\{ exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right) + exp\left(-\frac{(z+H)^2}{2\sigma_z^2}\right) \right\} \quad \text{(Eq. 3)}$$

The second term in equation 3, $(z+H)^2$, takes into account eddy reflection. The division of the emission rate by the wind speed results in units of [MASS/LENGTH] . This value is multiplied by the two normal density functions, one for the horizontal direction, and one for the vertical direction. The product of the two density terms has units of [1/AREA]. The overall product is a concentration with units of [MASS/VOLUME].

Associated with the Gaussian model and all dispersion models based upon the Gaussian model are the following assumptions (Turner, 1994):

- Continuous Emissions - The emission rate of pollutant does not vary over time.
- Conservation of Mass - During transport, no pollutant is lost due to chemical reaction, settling, or turbulent impaction.
- Steady-State Conditions - Meteorological conditions remain constant over the time of transport.
- Crosswind and Vertical Concentration Distributions - Both concentration distributions are assumed to be well represented by a Gaussian, or normal, distribution at any distance downwind or any distance in the crosswind directions.

It is obvious that there are cases where some or all of these assumptions do not hold. "The assumptions used in the derivation, frequently, do not hold. Emissions may vary with time. Pollutants may be lost due to settling or chemical reactions. Wind fields may vary with height. Inversion layers may exist. The diffusion constants may vary. Because of these and other cases where the assumptions do not hold, care must be taken when using the Gaussian equation." (Veigele and Head, 1978) In order to produce concentration estimates that are as accurate as possible, the Gaussian Dispersion Model should be applied to a situation that satisfies as many of these assumptions as possible.

Time Frame Associated with the Application of Gaussian Model

One of the main assumptions of the Gaussian dispersion model is that of steady state meteorological conditions. (Zannetti, 1990) In other words, the Gaussian equation "..refers to a stationary state (i.e., C is not a function of time)..." (Zanneti, 1990), and it "...uses meteorological conditions (wind and turbulence states) that must be considered homogeneous and stationary in the modeled area..." (Zanneti, 1990). Assuming the wind speed and direction remain constant in a given location for one hour, the concentration measured for that hour will be the same as a one minute sample in the same location. Regardless of the time, a period of constant wind speed and direction modeled by the Gaussian equation, will result in a concentration that is valid for that period.

Also related to the meteorological conditions and the time frame of application are the dispersion parameters, σ_y and σ_z. These are empirical values that were developed from recorded sampling data, using mathematical analysis. In theory, they represent the distance of horizontal and vertical spread of the plume. Mathematically, they are the standard deviations associated with the normal distributions in the Gaussian equation. There is controversy surrounding these parameters, pertaining to the valid time period of their application. Present models, such as ISC-SCREEN3 and ISC-ST3, apply these values over a 1 hour period. The result of this application is an assumption of constant wind speed and direction for one hour, which according to Pasquill (1961) is "...difficult, if not impossible, to find any example of atmospheric turbulence in which these conditions are strictly satisfied...". Williams (1996) in her research, found the SCREEN3's one hour concentration corresponded to a ten minute concentration as calculated by the Gaussian dispersion model (equation 1). She also found that SCREEN3's 24 hour concentration corresponded to a one hour concentration as calculated by the Gaussian dispersion model.

Zanneti (1990), referencing Gifford (1976), stated that σ_y and σ_z were derived based on concentration readings taken every three minutes. Pasquill (1961) also denotes that the measurements used in developing the sigmas were from a source with three minute duration periods. Venkatram (1995), alluding to the Prairie Grass Experiment that was the basis for Pasquill's estimates of the sigmas, states that the experiment consisted of 70 runs, and that each run was about ten minutes in length. Cooper and Alley (1994)

explicitly say that the "...concentration predicted by [the Gaussian Model], using the σ_y and σ_z values from [the Pasquill-Gifford-Turner curves], is a 10-minute-average concentration." Given the variation of time periods among the literature, there is no universally agreed upon time frame of application. Beychok (1996), in the following paragraph, provides a good summation of this issue.

> "A major problem with the Gaussian dispersion equation is defining what the calculated concentration C represents when using Pasquill's dispersion coefficients. D.B. Turner states that C represents a 3- to 15-minute average; and American Petroleum Institute dispersion modeling publication believes C represents a 10- to 30-minute average; S.R. Hanna and P.J. Drivas believes C is a 10-minute average; and others attribute averaging times from 5 minutes to 30 minutes. Most agree on a range of 10 minutes to 15 minutes. However, many Environmental Protection Agency computer models used to determine regulatory compliance assume that the Gaussian dispersion equation yields 60-minute average concentrations."

Re-examination of Gaussian Equation

A re-examination of the assumptions of the Gaussian equation should be the basis of the new model. Knowing that the Gaussian dispersion function was derived specifically for steady state meteorological conditions, the conclusion can be drawn (as mentioned earlier) that the dispersion function is completely time independent. The only parameter that determines what time-average the modeled concentrations represent is the time period for which steady-state meteorological conditions were found.

The values of the σ_y and σ_z dispersion parameters are functions of meteorological stability class and downwind distance. Their function in the model is to define the horizontal and vertical boundaries of the plume. When these values are reported in literature, they are grouped according to stability class, which is based on the wind speed and amount of incoming solar radiation. It is believed that when Pasquill originally formulated these values, he correlated the plume size to the wind speed. In other words, the use of the sigmas does not take into account significant variation in the wind direction, but are based on a time period of constant wind speed and wind direction. The size of the plume is therefore, based on the atmospheric stability, as determined by the wind speed and incoming solar radiation. The application of the sigmas (σ_y and $\sigma_{z)}$ in the new model should consist of utilizing these values in the dispersion model equation for small meteorological time increments (1 to 2 minutes). This application is intended to insure that the model predictions of concentrations are for time periods when the meteorological conditions are constant.

Even within a small time period, such as ten minutes, the wind speed, and, more importantly, the wind direction does not remain constant. The stability classes, and thus, the dispersion parameters are grouped according to wind speed ranges and not wind direction variations. The result is that in the present applications of the model, there is no method to account for changes in predicted downwind concentrations due to wind direction variations for periods of less than one hour. Our new model should apply the dispersion parameters and the Gaussian dispersion equation over small intervals of time in order to account for changes in downwind concentrations as a consequence of changes in wind direction.

Purpose of New Model

The overall purpose of developing a new air dispersion model is to provide a method that can be used to accurately predict concentrations of pollutants downwind from a source.

More specifically:

- To develop a dispersion model for ground-level area sources.
- To develop a dispersion model that accounts for meteorological variation over a modeled time period.
- To provide a regulatory tool for use in determining emission concentration characteristics of sources.

New Ground-Level Model Methodology

As a result of a re-analysis of the Gaussian equation assumptions, a new model is being developed. The major change made in the new model is a change in the averaging time. The Gassuian calculation approach is used, but the concentration calculated by the equation uses the wind speed and wind direction for a 2 minute period, and is thus a 2 minute concentration. Zwicke (1998) discusses this in more detail. Included in the paper by Zwicke, are validation studies using concentrations that were measures at known downwind distance from a source of know emission rate, and concentration estimated by the Gaussian equation using the 2 minute weather data. The estimated concentrations are within 5 to 10% of the actual concentrations. Another change made to improve performance for use with ground-level, area sources is the replacement of the normal distribution in the vertical plane with a triangular distribution. Figure 2 below shows the difference between the two distributions.

The triangular distribution will more accurately characterize dispersion in the vertical plane. Unlike the normal distribution, the height of the maximum concentration can change. The normal distribution has a maximum concentration "spike" at ground level. The triangular distribution has three different points, as shown by Figure

3. By setting each of these points, the size and shape of the plume can be represented. Like the normal distribution, the triangular distribution can be mathematically represented. The mathematical expression for the triangular distribution is as follows.

Equations 4 and 5 give the density function for the triangular distribution (Pritsker, 1979):

$$f(x) = \frac{2(x - A)}{(M - B)(B - A)} \rightarrow A \leq x \leq M \qquad \text{(Eq. 4)}$$

$$f(x) = \frac{2(B - x)}{(B - M)(B - A)} \rightarrow M \leq x \leq B \qquad \text{(Eq. 5)}$$

For ground-level sources, A is a ground-level and has a value of 0 meters. B is the height of the plume, and is set as a function of the dispersion parameter, σ_z. A value for B equal to $3\sigma_z$, will include 99.7% of the pollutant into the plume. M is height of maximum concentration, and is also a function of σ_z. M can be varied for different types of pollutant. Our hypothesis is that gaseous pollutants will disperse more rapidly than will particulate. This means that for gases, the plume height, B, and the height of maximum concentration, M, will be a higher multiple of σ_z than the values set for particulate dispersion. So, a gaseous plume will increase in height more rapidly that a particulate plume. The ability to vary B and M allows for the dispersion characteristics to be set based on the pollutant type. As this demonstrates, the triangular distribution allows for the modification of dispersion rate for different types of pollutants.

Replacing the normal distribution in the vertical plane (Equation 3) by the expression for the triangular distribution (Equations 4 and 5), the new models takes on the form of Equation 6.

$$C = \frac{Q}{u} * fy * fz \qquad \text{(Eq. 6)}$$

where:

fy is Equation 2; and
fz is Equations 4 and 5.

Now that a new model has been theorized and put to form, validation data is needed to test models performance. The data located for this purpose was supplied by the Air Quality Group at the University of California, Davis.

Air Quality Group Test Data

The Air Quality Group of the Crocker Nuclear Laboratory (CNL) of the University of California, Davis provided results of their studies on sources and sinks of PM_{10} in California's San Joaquin Valley. These studies measured PM_{10} and $PM_{2.5}$ concentrations associated with agricultural field operations, and used a dispersion modeling routine to determine the emission rate associated with each field operation.

The sampling itself measured PM_{10}, $PM_{2.5}$, and recorded meteorological data, time of samples, duration of samples, type of operation, area covered, and geographical location. The concentrations sampled were then used to back into an emission rate using a "sliding box model" as derived by the CNL. The emission factor was determined using the Equation 7 (Flocchini, 1995).

$$E = \frac{Ci * Vi * \cos\theta * \Delta Zi * t}{n * w} \qquad \text{(Eq. 7)}$$

where:

Ci = Concentration at height i
Vi = wind speed at height i
θ = angle from perpendicular
ΔZi = height of layer i
t = measurement time
E = emission factor
w = width of harvester pass, and
n = number of passes.

The theory behind this model assumes a uniform concentration across the entire field, and assumes that all of the particulate emitted is confined to the height of the defined box and to the width of the field. More simply, all of the particulate emitted from the field is channeled through the filed in an imaginary "duct" with dimensions of the height of the box and the width of the field. It is assumed that the concentration is uniform anywhere within any cross-section taken along the field width. That is, that anywhere within the "box" the concentration will be the same. Figure 4 gives a graphical representation of this.

The emission rate is calculated in terms of MASS / AREA. Dividing by the time of the sample will result in units of MASS / AREA*TIME. This allows comparison with results from our modeling routine.

Method for Emission Rates Estimates Using FRITZ-ZWICKE Model

The PM_{10} concentrations measured in the CNL study were used along with meteorological and sampling site data to back calculate emission rates using the newly developed FRITZ-ZWICKE (F-Z DM) dispersion modeling routine. As mentioned earlier the F-Z DM takes into account variation in wind direction by using two-minute averaging periods for the downwind concentration calculations. The meteorological data collected by the CNL was used in the concentration calculation procedure. The CNL box model assumes one wind direction and speed in the emission rate calculation. Based on the meteorological data provided by

CNL, a discrete probability distribution was developed for the wind direction. The reason for using a probability distribution and not the actual weather data is that the weather data file had wind directions and speeds recorded every five minutes instead of the required two minute intervals. A discrete distribution allows the concentrations to be calculated based on the same meteorological profile seen during the sampling period using generated two minute intervals of data. The wind speed was varied uniformly based on the high, low, and average speed as recorded by CNL.

The F-Z DM for ground-level area sources calculates downwind concentrations based on concentrations determined for individual point sources within the area. That is, for a single two minute period of time with a single wind speed and direction, a concentration at a single point downwind is determined for individual point sources within the designated area. For example, a 2 by 2 area is made up of 4 individual 1 m^2 point sources. The concentrations determined for each individual point source for a single two minute interval are summed to give the overall downwind concentration estimate for that two minute period. Then each of the individual two-minute total concentrations are averaged over a given time period to result in the concentration estimate for that time period. For example a 30 minute period is the result of the average of 15 two-minute total concentrations.

In the case of the CNL data, downwind concentrations were known, but not emission rates. To determine the F-Z DM estimated emission rate, a concentration was calculated by the F-Z DM using the CNL's estimated emission rate in MASS \ AREA * TIME. The estimated concentrations were lower than CNL's actual measured concentrations. Equation 10 was used to determine what emission rate would be required to result in an estimated concentration that matched the actual concentration using the F-Z DM.

$$ER_{req} = DN_{meas}\left(\frac{ER_{\mathrm{mod}}}{DN_{\mathrm{mod}}}\right) \qquad \text{(Eq. 10)}$$

This procedure was performed for the following agricultural field operations; Cotton Picking, Stalk Cutting, and Stalk Incorporation. Three separate test for each operation were taken from the CNL study and analyzed the F-Z DM procedure discussed above. The following models were used to estimate emission rates:

- F-Z DM version A with B = $3\sigma_z$ and M = $0.75\sigma_z$
- F-Z DM version B with B = $2\sigma_z$ and M = $0.5\sigma_z$
- F-Z DM version C with B = σ_z and M = $0.5\sigma_z$
- F-Z DM version D with B = σ_z and M = $0.25\sigma_z$
- F-Z "Box" DM with B = 4m and M = 1m
- SCREEN3

The purpose of the F-Z "Box" DM is to try to simulate CNL's Box Model to provide a direct comparison. A value of 4 m for B represents the CNL box heigh of 4 m. A value of 1 m was set for M to correspond to the height of sampling.

Tables 1 thru 3 show the results from each of the tests that were analyzed using the different models. The emission rates predicted by each model are shown. For the purposes of comparing the other models predicted numbers to the CBM predicted emission rate, the data is also presented in terms of number of multiples of the CBM predicted emission rate. For example, if the CBM emission rate was 1 $\mu g/m^2$*s and the F-Z ver A predicted emission rate was 5 $\mu g/m^2$*s, then the *Multiple of CBM* value would be 5.

Discussion

The most obvious trend observed is that the F-Z DM version A, B, and C all results in emission rate estimates that are higher than CNL's Box Model (CBM). But, comparing the emission rates predicted by the CBM to the emission rates predicted by SCREEN3, the F-Z DM version D, and the F-Z "Box" DM, similar predicted results are seen. Making the same comparison in terms of using the same emission rate to estimate the downwind concentrations using all models, the CBM, SCREEN3, the F-Z DM version D, and the F-Z "Box" DM will all give downwind similar concentrations. Versions A, B, and C of the F-Z DM will give lower downwind concentrations than those predicted by the other four models. Based on Williams (1995) citing that SCREEN3 is a conservative model coupled with the results seen here, we can conclude that the CBM, the F-Z DM version D, and the F-Z "Box" DM are also conservative models. That means that for a given emission rate, the estimated downwind concentration is higher than what would actually be sampled. Or, as seen in this study, for a given downwind concentration, the emission rate predicted is lower that the actual source emission rate. This then leads to the conclusion that version A, B and C of the F-Z DM are more accurate models, in the sense of predicting values closer to what would be sampled. Which of them is the most appropriate for particulate? More scientific data on plume profiles is needed to determine to best fit for particulate. It is our hypothesis that version B will be close to the target model. We have already located potential sources to provided plume profiling data for the purpose of determining actual plume shape and dispersion behavior.

One major point to be made here is that this emission rate is based on an accurate dispersion model and not a conservative model. The emission rates predicted by the F-Z DM would result in inappropriate estimations of downwind concentrations when used in the CBM or in ISC SCREEN3. Any emission rates that are produced as a result of back-calculation with a dispersion model, should have a qualifier that states what model was used to calculate it and

that it is for use only in that model. Another point to be mentioned here is that the goal of our research is to developed a more accurate dispersion model for use in the regulatory process, *not* the development of low emission rates for agricultural processes. The emission rate calculations are used only to provide a basis of comparison to actual measured values for the purpose of model validation.

Conclusions and Summary

Why is it important to focus on having accurate dispersion models for use in the regulatory process? The acceptable ambient levels of airborne pollutants is continually decreasing. This means that the regulation associated with sources of air pollution is continually increasing. All sources of airborne pollutants are subject to this regulation. In a location like California's San Joaquin Valley, where cotton gins, feed mills, and grain elevators already have BACT (Best Available Control Technology) or MACT (Maximum Available Control Technology) in place, and the ambient level of pollutant is still above the set ambient standard, other sources of that pollutant are going to be targeted. Fugitive emissions are already being regulated. In some areas, field operations are being limited to a certain number of days that the producer is allowed in the field. Cattle feed lots are regulated and are required to have methods to control fugitive dust. The use of overly-conservative models could results in excessive regulation of sources. This could potentially result in unreasonable expectations on controlling fugitive emissions. For example, the installation dust reduction devices on tractors and their implements, or a very limited number of allowed days of operation. There is a point where the required emission limits will be impossible to meet. The use of an accurate dispersion model will alleviate some of these problems by providing accurate estimates of downwind concentrations, and not extremely conservative estimates. This will keep money in the pockets of these sources, and still provide regulation that protects the public.

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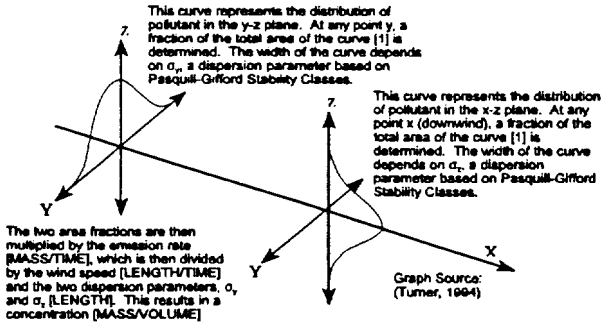

Figure 1. Graphical Representation of the Gaussian Dispersion Model

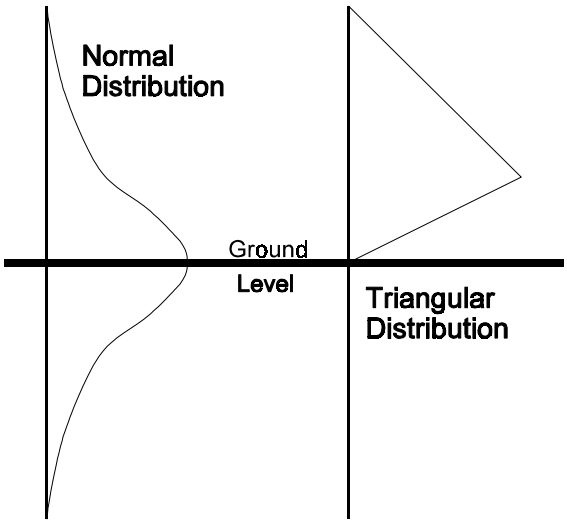

Figure 2: Normal versus Triangular Distribution

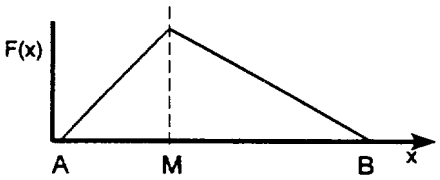

Figure 3: Triangular Distribution (Pritsker, 1979)

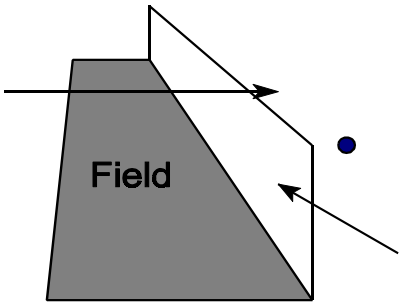

Figure 4: Box Model

Table 1. Emission Rate Estimations from Cotton Picking Operations.

Model	Test 1		Test 2		Test 3	
	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM
CBM	8	1	14	1	48	1
F-Z ver A	24	3	34	2	180	4
F-Z ver B	71	9	94	7	538	11
F-Z ver C	91	1	107	8	690	14
F-Z ver D	206	25	243	17	1533	32
F-Z "Box"	9	1	27	2	50	1
SCREEN3	23	3	35	3	62	1

Table 2. Emission Rate Estimations from Stalk Cutting Operations.

Model	Test 1		Test 2		Test 3	
	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM
CBM	31	1	1071	1	18	1
F-Z ver A	301	10	2500	2	37	2
F-Z ver B	904	29	6071	6	109	6
F-Z ver C	1175	37	8500	8	143	8
F-Z ver D	2670	85	20238	19	332	19
F-Z "Box"	100	3	2656	2	43	2
SCREEN3	72	2	789	1	17	1

Table 3. Emission Rate Estimations from Stalk Incorporation Operations.

Model	Test 1		Test 2		Test 3	
	Emission Rate ($\mu g/m^2*s$)	Multiple of BM	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM	Emission Rate ($\mu g/m^2*s$)	Multiple of CBM
CBM	4	1	105	1	24	1
F-Z ver A	39	10	227	2	49	2
F-Z ver B	115	31	275	3	92	4
F-Z ver C	147	39	366	4	119	5
F-Z ver D	336	90	805	8	266	11
F-Z "Box"	11	3	282	3	54	2
SCREEN3	8	2	48	0.5	38	2