Exposure Assessment Approaches For Chemicals Used As Soil Fumigants

Consideration Of The Probabilistic Exposure And Risk Model For Fumigants (PERFUM) - A Case Study With Iodomethane

Presented To The FIFRA Science Advisory Panel By:

U.S. EPA Office Of Pesticide Programs
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1 INTRODUCTION

On August 24-25, August 26-27, and September 9-10, 2004, the FIFRA Scientific Advisory Panel (SAP) will hold three separate meetings to consider and review three fumigant bystander exposure models. At the August 24-25 meeting the SAP will review the Probabilistic Exposure and Risk model for FUMigants (PERFUM) using iodomethane as a case study. On August 26-27, the SAP will review the Fumigant Exposure Modeling System (FEMS) using metam sodium as a case study. On September 9-10, the SAP will review the SOil Fumigant Exposure Assessment system (SOFEA(copyright)) using telone as a case study. In preparing for these meeting, preparation of this document, and development of questions for the Panel, the Agency has worked closely with scientists from the California Department of Pesticide Regulation who have significant experience with inhalation exposure modeling.

The purpose of this document is to provide general background information for the FIFRA Science Advisory Panel (SAP) meeting pertaining to the evaluation of the *Probabilistic Exposure And Risk Model For Fumigants* (or PERFUM). PERFUM represents a potential evolution of the Agency's current methodology for calculating exposures to bystanders who can be exposed by being in close proximity to fields treated with soil fumigants prior to planting crops such as strawberries or tomatoes. PERFUM was developed by the registrants (i.e., manufacturers or licensees) of the soil fumigant iodomethane. At the upcoming SAP meeting, a detailed PERFUM case study will be presented based specifically on iodomethane data for illustrative purposes by its developers. More specific background materials pertaining to the theories and code included in PERFUM than there are in this document, are available in the following which has been provided by its developers for consideration (available at: http://www.epa.gov/oscpmont/sap/2004/#top).

A Probabilistic Exposure And Risk Model For Fumigant Bystander Exposures Using Iodomethane As A Case Study, Reiss and Griffin, July, 2004

The Agency has a broad range of goals for this meeting in that it wishes to evaluate the methodologies inherent in PERFUM from a general perspective to (1) determine their scientific validity and (2) determine if there is any general applicability for evaluating risks associated with many or all soil fumigants. There are three key criteria that the Agency considers when considering the integration of a model into its risk assessment process and these include: (1) public availability; (2) peer review for scientific validity; and (3) adherence to Agency guidelines for model development. In order to have PERFUM considered by the Agency and by the SAP the developers of PERFUM have agreed to make it available for public use.

The Agency is currently involved in the development of a comparative risk assessment for 6 pesticides that are used for soil fumigation purposes. Some of these chemicals also have other allowed uses but, for clarity, the discussion within this document focuses only on soil fumigation since it is of key concern and it accounts for the majority of the annual usage for each chemical. The chemicals which are included in this assessment are: chloropicrin, dazomet, iodomethane (i.e., methyl iodide), methyl bromide, metam-sodium (or other salts), and telone (or 1,3-dichloropropene). Each of these chemicals (or their breakdown products, metam-sodium and dazomet both emit MITC or methyl isothiocyanate which is the volatile component) are extremely volatile especially when compared to most common pesticides. Most common pesticides are considered semi-volatile organic chemicals (or SVOCs) while soil fumigants would be considered volatile organic chemicals (or VOCs). The volatility of each material is the key characteristic associated with their use and achieving a satisfactory measure of efficacy. This volatility, however, can lead to a potential for human exposures because it leads to transport away from targeted application areas to non-target receptors such as nearby human populations.

The Agency's goal for this risk assessment is to quantify emissions from treated fields and use them as a determinant of human risks. Emissions from treated fields can be categorized in two ways including:

(1) **Known Source:** include those directly associated with a single application (or series of associated applications) adjacent to a receptor where the source and emissions specific to the application(s) can be quantified. An example would be treating a field that borders a residential subdivision then defining the amount of off-target residue movement associated with that specific application. The concept of a buffer zone as a risk management tool is commonly associated with these situations.

(2) **Multiple Source (Ambient Air):** includes those associated with multiple applications or general use within a region where many non-quantifiable applications can possibly contribute to overall exposure levels. In general, ambient exposures within a region cannot be easily attributed to specific application events. An example of this type of emission might be those air concentrations measured at a school location when the school is located within a growing region where fumigants are extensively used. The concept of a localized use cap as a risk management tool is commonly associated with these types of exposures.

A discussion and quantification of each type of emission will ultimately be included in the Agency risk assessment for soil fumigants, however, the focus of this document and the upcoming SAP meeting is the *Probabilistic Exposure And Risk Model For Fumigants* (or PERFUM) which is intended to quantify emissions from single, known applications (e.g., treating a field with a subdivision immediately adjacent to its perimeter).

In order to quantify emissions from single application events, the Agency currently uses an approach that first considered the monitoring data available for each of the six soil fumigants along with a deterministic modeling approach. It was clear that given the breadth of the uses associated with soil fumigants (e.g., varied atmospheric conditions, application methods, and emission reduction technologies such as tarping or watering in) that use of monitoring data alone for risk assessment purposes was limited by the relatively small number of samples which can reasonably be generated for different times after treatment, distances from the application site, and use patterns. This conclusion led to the development of the Agency's current modeling approach and the possible evolution of that approach represented by PERFUM. The model-based approach considers temporal and spatial factors, extrapolating from available monitoring data, thus providing an estimate of the range of exposures which are possible at different times and locations when input parameters are varied. Use of a model and monitoring data are, however, intertwined in a general sense because monitoring data are used as the basis for estimating emission factors used in the model.

The Agency is currently using a deterministic modeling approach for defining air concentration gradients downwind of applications for each chemical. In this approach, the Agency has based its analysis on a standardized set of meteorological conditions intended to represent a stable atmosphere and unidirectional wind patterns that is intended to provide high-end estimates of exposure. To this end, the Agency has developed a methodology based on the Office of Air model ISC3 (Industrial Source Complex Model) that is routinely used for regulatory purposes. ISC3 is a steady-state Gaussian plume model which can be used to assess pollutant concentrations from a wide variety of sources. ISC3 is a publically available system and can be downloaded from the Agency (http://www.epa.gov/scram001/tt22.htm#isc).

Stakeholders have commented to the Agency a belief that these standardized meteorological conditions are not representative of actual atmospheric conditions where soil fumigants are used and therefore solely provide screening level results which are inadequate for risk mitigation decision making purposes. To this end, the iodomethane registrant has submitted to the Agency the PERFUM model for consideration. PERFUM integrates actual meteorological data into ISC3 which then provides for the calculation of multi-directional air concentration gradients based on these data. As with the Agency's approach, these resulting concentration gradients would ultimately be used as a determinant of human health risks. Additionally, it should also be noted that the PERFUM model uses a probability based approach for integrating emission data which are unique to this system.

This document describes the Agency's current approach for model use in *Section 2: Summary Of Current Modeling Approach*. *Section 3: Overview of Probabilistic Exposure And Risk Model For Fumigants (PERFUM)* provides a brief summary of the approaches that have been incorporated into the system. *Section 4: Charge To Panel* details the specific questions pertaining to the use of PERFUM which the Agency would like the SAP panel to address in its deliberations.

2 SUMMARY OF CURRENT MODELING APPROACH

The goals of the Agency in its fumigant assessment are to develop health protective measures of risk for populations in close proximity to fields that have been treated with soil fumigants as well as to explain and reduce, whenever possible, the uncertainties associated with these analyses. In order to achieve these goals, the Agency first considered monitoring data specific to each chemical but due to the limitations of those data and the flexibility that modeling represents have focused on model results as the key predictor of risks.

The Agency's current exposure assessment approach is based on a deterministic use of the Agency's Industrial Source Complex Model (ISC) which is routinely used by the Office of Air for regulatory decision making purposes. It is available from the following website at the *Technology Transfer Network Support Center for Regulatory Air Models (or SCRAM)* (http://www.epa.gov/scram001/tt22.htm#isc). ISC is a steady-state Gaussian plume model which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex or from other types of sources such as an agricultural field in this case. This model can account for the following: settling and dry deposition of particles; downwash; point, area, line, and volume sources; plume rise as a function of downwind distance; separation of point sources; and limited terrain adjustment. ISC can operate in both long-term and short-term modes but has been used in the short-term mode for the purposes of this assessment.

The Agency's current approach is summarized herein. *Section 2.1 Input Variables And Settings Used For ISC Calculations* describes the current modeling approaches used by the Agency including a description of the specific inputs and ISC settings used for the calculations. *Section 2.2 Outputs Based on Current Modeling Approach* provides examples of the outputs from ISC that might be presented for consideration by risk managers. To ensure a level of consistency in the evaluation of the PERFUM model, the examples presented below to describe the current Agency methodology are also based on a case study using iodomethane.

2.1 Input Variables And Settings Used For ISC Calculations

In order to define concentration gradients associated with the use of soil fumigants, which are ultimately determinants of exposure, the Agency utilized ISC by equating treated agricultural fields to an area source coupled with inputs that reflected a range of potential atmospheric conditions and application equipment/techniques used for the different fumigant chemicals. In order to do this, the Agency considered various combinations of four categories of input variables including:

- Field Size;
- Atmospheric Conditions;
- Application Equipment and Control Technologies; and
- Field Emissions Associated With Application Equipment and Control Technology.

[Note: As a convention, the Agency has used similar input variables for all of the 6 soil fumigant chemicals wherever possible. This allows for an easier determination of the relative risks amongst the 6 soil fumigants. Some input factors such as emission data, however, are by nature chemical-specific and have been treated as such in analyses completed by the Agency. This is the rationale behind providing a separate section which details how the emission data were analyzed for iodomethane.]

Field Size: The Agency generically is using a range of field sizes for single application events from 1 acre up through 40 acres. Specifically, the Agency based its calculations on field sizes of 1, 5, 10, 20, and 40 acres. It is believed that most distinct soil fumigation application events will be within this range of areas treated. It is also acknowledged larger fields could be treated on a single day. Results could easily be scaled to those larger acreages if needed. These field sizes are also essentially consistent with analyses completed by the California Department of Pesticide Regulation which allows for easy comparison with their results. Field geometry can also impact the results of ISC modeling. For ease, the Agency has by convention completed all of its analyses based on the use of square fields.

Atmospheric Conditions: ISC calculates downwind air concentrations using hourly meteorological conditions, that include wind speed and atmospheric stability (for a more detailed discussion of stability see http://www.epa.gov/scram001/userg/relat/pcramtd.pdf). The higher the letter associated with a stability class the more stable the atmosphere becomes. The lower the wind speed and the more stable the environment, the higher the air concentrations are going to be close to a treated area (or source). Conversely, if wind speed increases or the atmosphere is less stable, then air concentrations are lowered in proximity to the treated area thereby lowering the potential for exposure. Atmospheric stability is essentially a measure of how turbulent the atmosphere is at any given time. Stability is affected by solar radiation, wind speed, cloud cover, and temperature among other factors. Instability in the atmosphere increases the movement of airborne residues because they are more readily pushed up into the atmosphere and moved away from the source thereby lowering concentrations in close proximity to the source (e.g., treated field).

In order to simplify modeling the transport of soil fumigant vapors from a treated field, a single wind direction, wind speed, and stability category are used for a given duration of concern (i.e., 24 hours). The Agency has decided to present a series of results based on a range of possible, and plausible, meteorological conditions to allow for a better characterization of risks compared to just completing the analyses based on a single set of meteorological conditions. The different conditions considered by the Agency are presented in Table 1.

For comparative purposes, the California Department of Pesticide Regulation, in its determination of buffer zones for methyl bromide, based its decisions upon a windspeed of 1.4 m/s and a class C atmospheric stability value for a 24-hour period. During the daytime hours, these conditions represent a stable atmosphere which is relatively calm but this stability is not considered overly calm for nighttime conditions. We believe these values provide higher-end air concentrations. [Note: This is supported by an analysis methyl bromide buffer zones by DPR available at: www.cdpr.ca.gov/docs/dprdocs/methbrom/mebrmenu.htm.]

Table 1: Meteorological Combinations Used in ISC Calculations

Wind Speed (mph)	Wind Speed (meters/second)	Stability Category#
2.25^	1.0^	F^
2.25	1.0	D
3.1*	1.4*	C*
4	1.8	C
5	2.2	C
6	2.7	C
7	3.1	C
8	3.6	C
9	4.0	C
10	4.5	C
10	4.5	B

= The lower the assigned "letter" the less stable the atmosphere. Categories A to D are generally seen in daylight conditions. Nighttime conditions are generally even more stable than even the most stable daylight conditions.
^ =Conditions only used for 1 hour exposure duration.
* = Conditions used in DPR assessment and risk management decisions for methyl bromide.

Application Equipment and Control Technologies: Application equipment and control technologies are varied and depend on many factors including the environmental fate characteristics of the chemical, terrain where the chemical is being used, economic considerations, and other agricultural practices. Application equipment can take many forms but applications typically involve the use of some sort of probe that is used to inject material beneath the surface of the soil, a broadcast application of a liquid solution or solid material across the surface of a treated area, or the delivery of chemicals through some sort of plumbed system throughout the treated area (e.g., some chemicals are delivered via irrigation water).

Along with the various application methods there are a number of control technologies that are intended to minimize the emissions from treated fields. These can take many forms but essentially involve one of three basic techniques that include: (1) change in injection depth and probe design; (2) use of tarping or bedding techniques; and (3) watering-in.

Ultimately, the goal of the Agency is to codify different combinations of application methods and control technologies in order to have these serve as a systematic basis for risk assessments. The ability to do this, however, varies depending upon the data available for each chemical. In some cases, such as methyl bromide, there is a preponderance of data that allows for characterization based on a large number of possibilities as described by the California Department of Pesticide Regulations in its permit conditions which are presented on their website (http://www.cdpr.ca.gov/docs/legbills/mebrbuffer.pdf).

The situation with iodomethane differs somewhat in that it has not been registered yet with any regulatory agency so no permit conditions or official labeling exists at this point. To complete its analysis, the Agency used proposed label language and the monitoring data that are available. The available data have been reviewed and three basic categories of application methods have been identified to date (Table 2).

Table 2: Summary Of Application Methods For Iodomethane

Application Method	Emission Reduction Technology	Combination #
Shallow shank, broadcast flat fume	Tarped	1
Shallow shank, raised bed	Tarped	2
Drip irrigation, raised bed	Tarped	3

Field Emissions Associated With Application Equipment and Control Technology: Emissions from treated fields are generally characterized as the amount of residues that are offgassing from a unit area per unit time. Emissions quantified in this manner are referred to as flux ($\mu g/m^2$-s). Flux rates are specific to the conditions of the field experiment for which they were generated but can be used in a generic sense by normalizing the data to the maximum application rate which was 175 pounds per acre. Flux rates were calculated using the back-calculation method with ISC. The ISC back-calculation method estimates flux rates by extrapolating from the available field air monitoring data, assuming a Gaussian plume distribution, to estimate the flux rate. The normalized flux rates which were determined for iodomethane are summarized below in Table 3.

Table 3: Summary Of Normalized Flux Rates For Iodomethane			
Application Method	**Emission Reduction Technology**	**24 Hour Flux Rates ($\mu g/m^2$ - s)**	**Combination #**
Shallow shank, broadcast flat fume	Tarped	107 (Manteca Site Data)	1
Shallow shank, raised bed	Tarped	85	2
Drip irrigation, raised bed	Tarped	66	3
Note: These values are subject to change as the Agency was finalizing these calculations during the time this document was prepared. Detailed information concerning these flux calculations will be presented by the Agency at the SAP meeting during introductory remarks.			

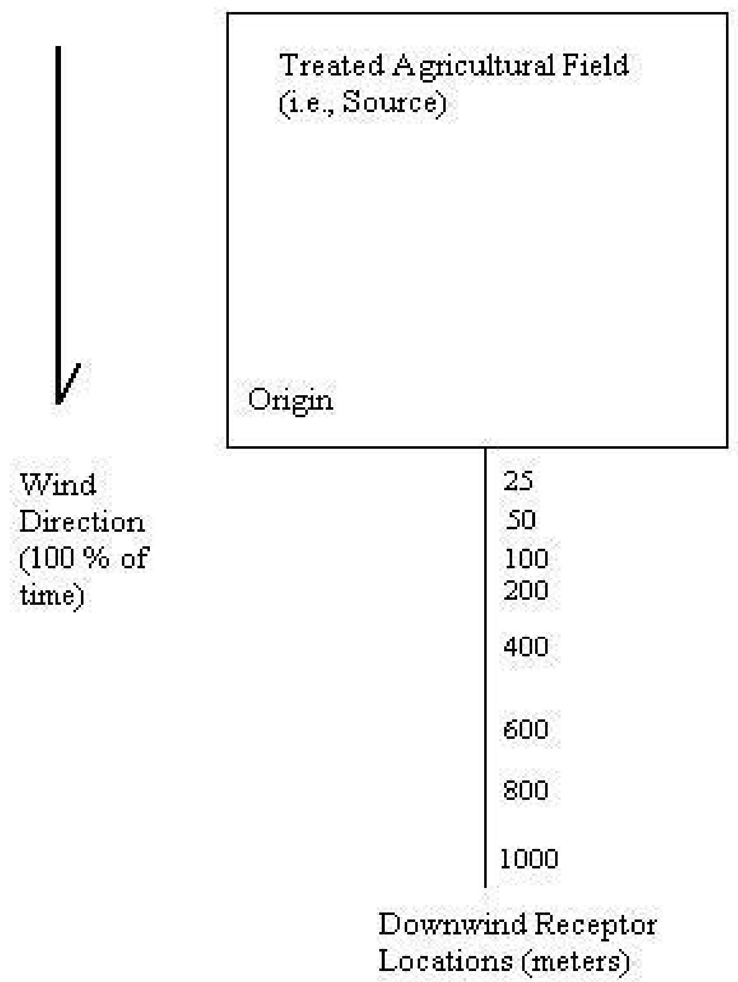
Other Settings/Parameters: Along with the input variables described above that have been considered by the Agency in this assessment there are other parameters (or settings) that must be defined in order to complete an ISC analysis. These parameters include (see Figure 1):

- Rural conditions are used;
- Mixing height 692 m for rural settings (based on DPR analysis);
- Receptor height at ground level (similar to DPR analysis);
- Source (i.e., the treated field) is treated as an area source;
- Source (i.e., the treated field) is square oriented in north/south direction;
- Grid origin is SW corner of field;
- Receptors are centerline of field to the south, buffers are from edge of field;
- Release height is 0 meters;
- Flux rates determined from monitoring data using ISC-based back calculation method as no direct measurements of flux were available for this analysis (i.e., sometimes referred to as indirect flux calculation method);
- Deposition is not accounted for and is expected to be minimal due to volatility of chemical; and
- Standard regulatory default options as defined in ISC User's Guide Volume 1 have been used.

2.2 Outputs Based on Current Modeling Approach

Examples of the kinds of outputs which can be generated by ISC based on inputs similar to those described above are presented in this section. For the purposes of this example, the outputs represent 24 hour average concentrations at selected downwind receptor points. The receptor points are illustrated in Figure 1 along with the unidirectional nature of the meteorological conditions (i.e., wind direction) upon which the assessment is based.

Figure 1: ISC Source & Receptor Grid - Std. Analysis



The results based on the Agency's methodology were calculated using a test case similar to one of those included as a case study in the PERFUM background document. The test case which was evaluated considered the exposures of individuals surrounding a field that had been treated via a tarped shallow shank, broadcast flat fume application. For comparative purposes, the Agency has summarized the results based on its deterministic approach for this scenario below. These results include air concentrations (µg/m^3) at selected receptor points downwind for a variety of meteorological conditions (Table 4). The conditions considered in this analysis range from a stable atmosphere conducive to higher concentrations in close proximity to treated areas to conditions that are much less stable which lead to lower concentrations in proximity to treated areas.

Table 4: ISC Calculated Air Concentrations At Selected Distances Downwind (µg/m^3) For Pre-Plant Agricultural Field Fumigations

ER	Fld Size (A)	DW Dist. (M)	Air Concentrations At Differing Meteorological Conditions									
			1 m/s 2.3 mph	1.4 m/s 3.1 mph	1.8 m/s 4 mph	2.2 m/s 5 mph	2.7 m/s 6 mph	3.1 m/s 7 mph	3.6 m/s 8 mph	4.0 m/s 9 mph	4.5 m/s 10 mph	4.5 m/s 10 mph
			Stab D	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab C	Stab B
0.47	1	25	2116	976	759	621	506	441	380	342	304	214
		100	935	395	307	251	205	178	153	138	123	73
		500	170	48	37	30	25	22	19	17	15	6
		1000	59	15	11	9.4	7.6	6.6	5.7	5.1	4.6	1.7
		2500	15	2.9	2.3	1.8	1.5	1.3	1.1	1.0	0.9	0.3
		5000	5.3	0.8	0.6	0.5	0.4	0.4	0.3	0.3	0.3	0.1
	40	25	5278	2342	1822	1491	1215	1058	911	820	729	507
		100	3314	1418	1103	902	735	640	551	496	441	300
		500	1456	564	438	359	292	255	219	197	175	99
		1000	942	309	240	196	160	139	120	108	96	43
		2500	434	93	72	59	48	42	36	32	29	9.7
		5000	186	30	23	19	16	14	12	11	9.4	3.4

Note: ER = emission rate which defines flux in terms of the percentage of the amount applied. The emission rate of 47 percent or 0.47 for this application method was calculated by dividing the flux rate of 107 µg/meter squared -second by the application rate of 175 pounds/acre/day after conversion to similar units and adjustment of the flux rate to a 24 hour value. The flux data upon which this analysis is based is from the Manteca flat fume study. There was another flat fume application study available that was conducted in Watsonville California. However, for illustrative purpose, the Agency has provided concentration estimates based on the Manteca information.

The air concentrations presented in Table 4 would then be used to calculate a risk estimate for each condition. The Agency uses *Margins of Exposure* to represent non-cancer risks which are calculated using the following formula:

$$MOE = \frac{HEC\ (\mu g/m^3)}{Air\ Concentration\ (\mu g/m^3)}$$

Where:

MOE	=	Margin of exposure, value used to represent risk or how close a chemical exposure is to being a concern (unitless);
Air Concentration	=	The concentration in air to which an individual could be exposed ($\mu g/m^3$); and
HEC	=	Human equivalent concentration is the air concentration of a toxicant at a level at which an effect might occur (e.g., NOAEL or LOAEL) after it has been adjusted to pharmacokinetic differences between the test animal species and humans.

In the PERFUM case study a "threshold" HEC value was used for the purposes of calculating simulated risk estimates 120 $\mu g/m^3$. This does not represent the actual HEC or "threshold" being considered by the Agency at this point and is only used for illustrative purposes. The Agency wishes to focus discussion at the SAP meeting on the methodologies contained in PERFUM that could potentially lead to an evolution in the manner in which the Agency calculates exposure concentrations such as in Table 4 and not on other risk assessment related issues specific to the iodomethane case study example. As such, the Agency has not included any risk estimates in this document for the case study.

3 OVERVIEW OF Probabilistic Exposure And Risk Model For Fumigants (PERFUM)

The *Probabilistic Exposure And Risk Model For Fumigants (PERFUM)* is a modeling tool that could potentially represent an evolution in the manner in which the Agency calculates exposures from soil fumigants. It is the methodologies included in PERFUM that the Agency wishes the SAP panel to consider in its deliberations. This section contains a very brief overview of the PERFUM system and how the outputs might differ from those generated using the current Agency approach for calculating exposures. Definitive discussions of PERFUM can be found in the following (http://www.epa.gov/oscpmont/sap/2004/#top).

A Probabilistic Exposure And Risk Model For Fumigant Bystander Exposures Using Iodomethane As A Case Study, Reiss and Griffin, July, 2004

The purpose of this discussion is to provide readers with a way to easily contrast the Agency approach and the approaches included in PERFUM. Much of the discussion in this section and the graphics included herein are excerpted directly from the above document. It should also be noted that the PERFUM developers used data specific to the soil fumigant, iodomethane, as the basis for the case-study included in this document (i.e., exposures were evaluated for each of the different categories of application methods described above in Table 2). The Agency believes that the methods applied in this analysis have generic applicability to all fumigants and wishes that PERFUM be considered in this manner yet keeping in mind that some of the inputs used for this analysis have to be specific to iodomethane in order to complete the case study analysis.

The PERFUM model was developed with three critical design considerations in mind including: (1) integration of actual meteorological data into an analysis; (2) the variability associated with emissions from treated fields; and (3) the need to evaluate uncertainty associated with the input parameters throughout a modeling analysis. PERFUM is based on an EPA model (ISCST). The PERFUM approach utilizes historical meteorological datasets and provides characterization of the potential downwind concentrations. Specifically, for an emission profile, PERFUM calculates the downwind concentrations in all directions around the field for every day for a 5-year period for every source of meteorological data considered. From these concentration calculations, PERFUM establishes distances from the field, in all directions, where the concentration declines to a user defined threshold. The PERFUM "modeling toolbox" also contains an additional program that can calculate margins of exposure (MOEs) for a defined concentration isopleth around a treated field.

Specifically, in the case study developed based on iodomethane, the following options/inputs were considered:

- Flux data from 6 distinct field monitoring studies that evaluated emissions from flat fume, raised bed, and drip irrigation applications;
- Emissions on the day of application and the days immediately following were considered;
- Direct and indirect flux estimates for the Manteca study were compared;
- Meteorological data from 4 sources including National Weather Service, Automated Surface Observing System, California Irrigation Management Information System, and Florida Automated Weather Network were considered;
- The impact of mixing height and the replacement of missing meteorological data were evaluated; and
- An uncertainty analysis was completed that evaluated emission inputs, meteorology and other general modeling issues such as the treatment of "calm wind" periods; terrain impacts; seasonal variation in applications, and exposures from multiple fields.

The following graphically describe a number of issues that were considered in the development of PERFUM, analysis of the data, interpretation of the results compared to the current Agency practice. Figure 2 provides a description of the receptor grid which is used in the PERFUM analysis. Table 5 provides numerical estimates for the number of receptors considered in a PERFUM analysis.

Table 5. Receptor Points for Various Field Sizes

Grid Type	Field Size (acres)	Number of Spokes	Number of Rings	Number of Receptors (Spokes*Distances)
Fine	1	96	28	2,688
	5	132	28	3,696
	10	152	28	4,256
	20	188	28	5,264
	40	232	28	6,496
Coarse	1	24	28	672
	5	33	28	924
	10	38	28	1,064
	20	47	28	1,316
	40	58	28	1,624

Figure 2. Receptor Grid For A 5 Acre Field (5 acre field in center; blue line is an example of a spoke)

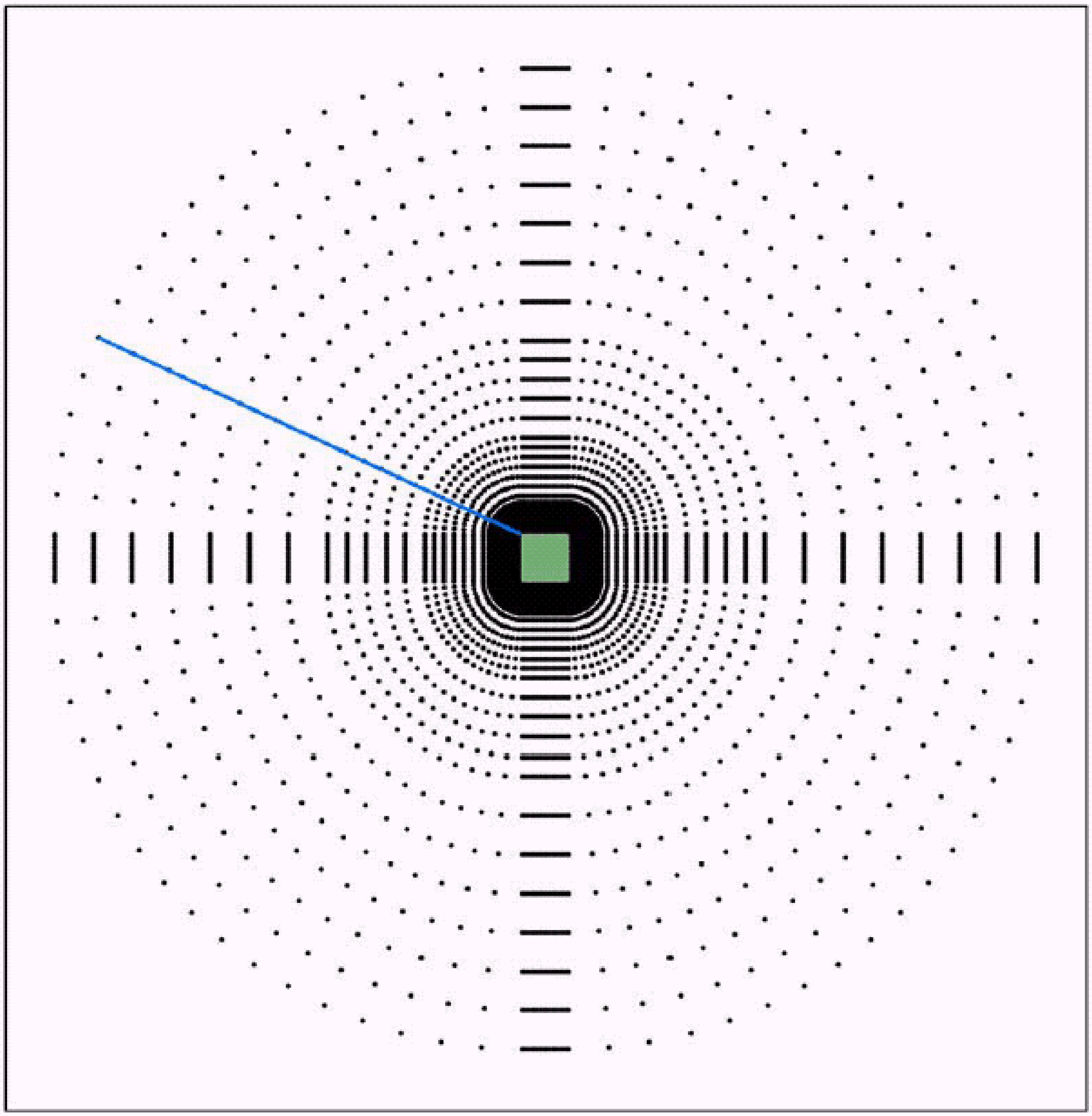
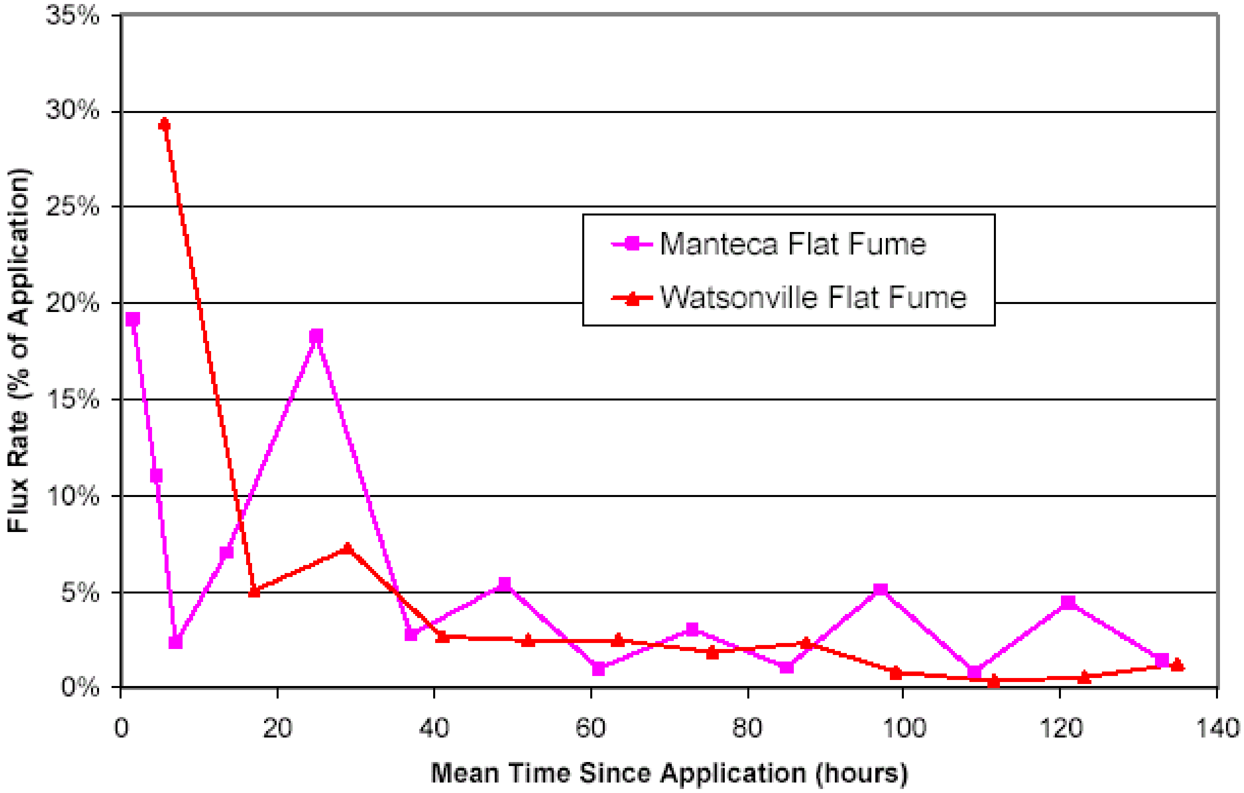


Figure 3 provides a comparison of emission rates from two fields treated via flat fume application. This figure also illustrates variability in emissions and a general decline in air concentrations over time. It should also be noted that Manteca data were selected as the basis for the analysis conducted by the Agency.

Figure 3. Estimated Flux Rate Versus Mean Time Since Application For Flat Fume Applications



Figures 4 and 5 provide a summary of the meteorological data used for the PERFUM analysis. Figure 4 illustrates the locations of the meteorological stations that were considered as sources of data in Southern California which is anticipated to be an area of substantial iodomethane use. Figure 5 presents windrose data for the Bakersfield ASOS station which illustrates how wind directions and speed changed over the selected period at that station.

Figure 4. Locations of Meteorological Stations in California

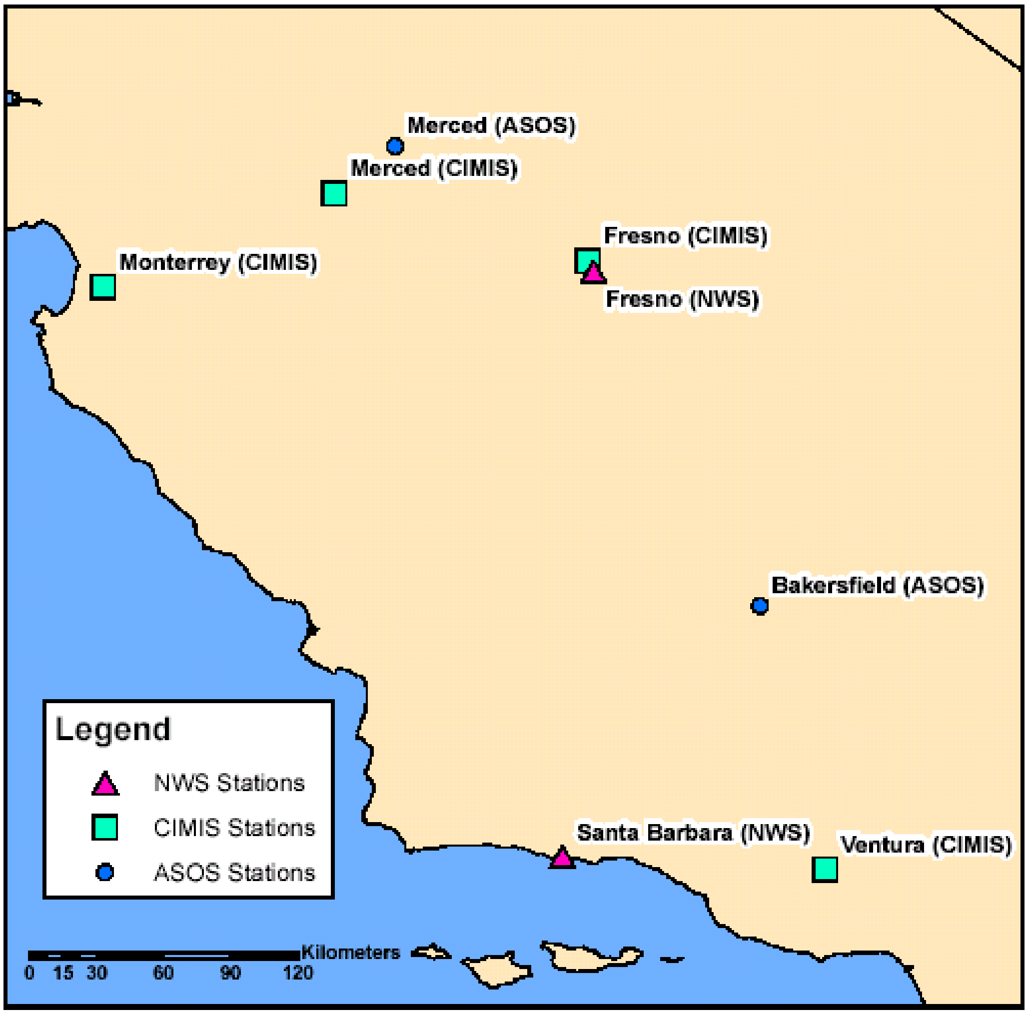


Figure 5. Wind Rose Plot For Bakersfield

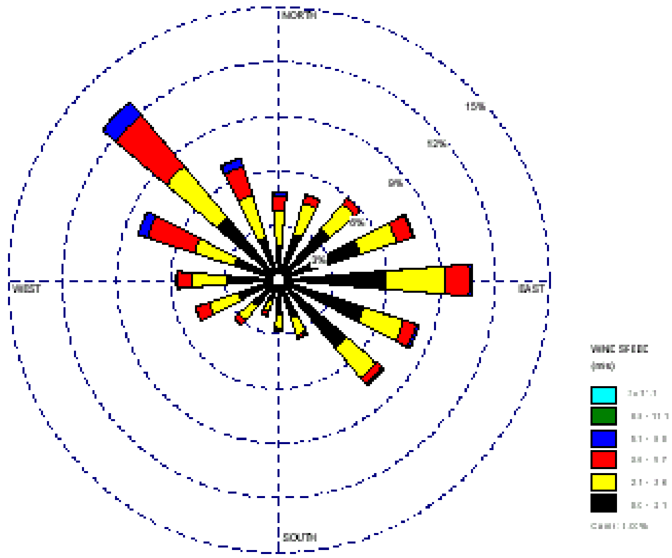


Figure 6 provides a comparison of the distributions of daily average windspeeds for selected meteorological stations in both California and Florida. Note that the results of this analysis can be used to assist in the characterization of the deterministic inputs used by the Agency and summarized in Table 4

Figure 6. Distribution Of Daily Average Wind Speeds at the Meteorological Stations

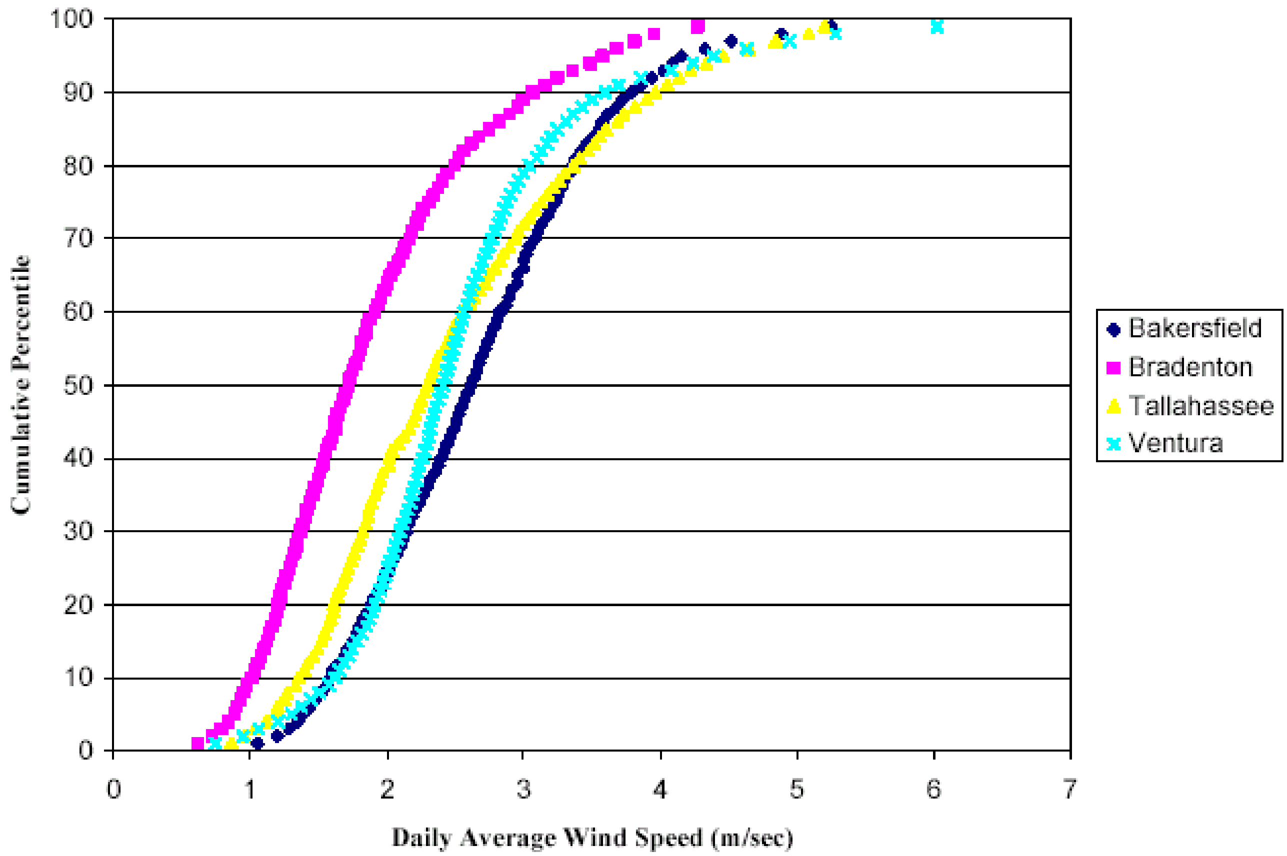
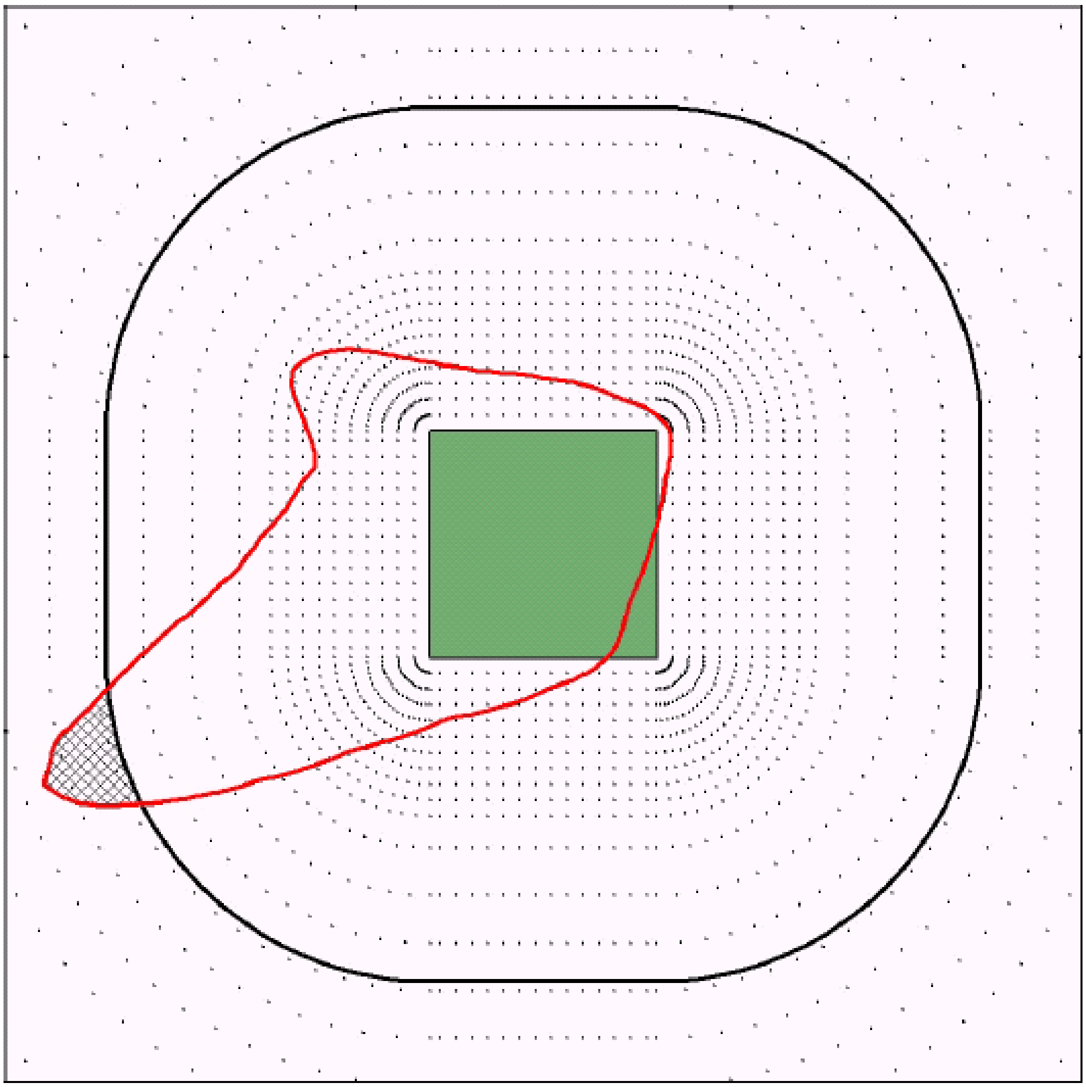


Figure 7 provides an example of the isopleths that can be produced using PERFUM. The example provided below is for a 5 acre field. It also illustrates how the results can be used for regulatory purposes and for examination of exposures which may exceed any specified threshold concentration.

Figure 7. Example Concentration Estimates For A 5 Acre Field (Red line shows contour at reference concentration; black line shows the buffer zone).



4 CHARGE TO PANEL

This section presents the charge questions the Agency wishes the panel to consider in its deliberations pertaining to PERFUM. The nature of these questions are varied and range from issues pertaining to the documentation, design, and operation of PERFUM to the manner in which results are presented. For simplicity, the Agency has grouped the questions by subject matter that reflect critical elements pertaining to the use of PERFUM and results generated by PERFUM. The key subject matter areas include: (1) documentation; (2) system design/inputs; and (3) how results are presented.

Critical Element 1: Documentation

Question 1: The background information presented to the SAP panel by the PERFUM developers provides both user guidance and a technical overview of the system. Please comment on the detail and clarity of this document. Are the descriptions of the specific model components scientifically sound? Do the algorithms in the annotated code perform the functions as defined in this document? Please discuss any difficulties encountered with respect to loading the software and evaluating the system including the presented case study?

Critical Element 2: System Design/Inputs

Question 2: In *Section 2.3: Development of the PERFUM Modeling System* of the background document, a series of detailed individual processes and components included in PERFUM are presented. The key processes include (1) incorporation of ISCST3 into PERFUM, (2) probabilistic treatment of flux rates; and (3) development of a receptor grid. Please comment on these proposed processes, the nature of the components included in PERFUM and the data needed to generate an analysis using PERFUM? Are there any other potential critical sources of data or methodologies that should be considered?

Question 3: The determination of appropriate flux/emission rates is critical to the proper use of the PERFUM model as these values define the source of fumigants in the air that can lead to exposures. Upon its review of how flux rates can be calculated, the Agency has identified a number of questions it would like the panel to consider. In PERFUM, flux rates were treated as a probabilistic variable with an uncertainty developed from the statistical bounds of the flux calculation. For each measurement period a standard error is generated that reflects the measurement uncertainty of the flux rate. PERFUM then perturbs the concentration estimates within each period by the standard error using Monte Carlo methods to simulate the uncertainty in the flux estimates. What, if any, refinements are needed for this process including the manner in which flux values were calculated for each monitoring period to generate the standard error estimates? How appropriate is it to use a flux/emission factor from a single monitoring study (or small number of studies) and apply it to different situations such as for the same crop in a different region of the country? Please comment on PERFUM's capability to adequately consider multiple, linked application events as well as single source scenarios? Does PERFUM appropriately address situations where data are missing? In the back-calculation approach used for estimating emission rates, the regression of measured versus modeled values can be forced through the origin or not. Which approach does the panel prefer and what are the implications of each approach?

Question 4: The integration of actual time-base meteorological data into ISCST3 is one of the key components that separates the PERFUM methodology from that being employed by the Agency in its current assessment. There are several potential sources of these data including the National Weather Service, Federal Aviation Administration, California Irrigation Management Information System (CIMIS), and the Florida Automated Weather Network (FAWN). The Agency is also aware that there are several approaches that can be used to process meteorological data and acknowledges that PERFUM used PCRAMMET which is a standard Agency tool for this purpose as well as other techniques in some cases (e.g., for the FAWN & CIMIS data). Various datasets from both California and Florida were used as the basis for the PERFUM case study. Please comment on the methods used to select monitoring station locations? What criteria should be used to identify meteorological regions for analysis and how should specific monitoring data be selected from within each region.? Please comment on the manner that data from the selected various stations were processed? Data quality and uncertainty associated with these data vary with the source. Does the panel agree with the approaches used to characterize these factors? Anemometer sampling height has been identified as a concern by the Agency in preparation for this meeting. What are the potential impacts of using data collected with different anemometer heights in an analysis of this nature? Does PERFUM treat stability class inputs appropriately? Does PERFUM appropriately calculate bounding air concentration estimates by concurrently using upper-bound meteorological and emission/flux inputs?

Question 5: The Agency model, ISCST3 is the basis for the PERFUM approach. This model has been peer reviewed and is commonly used for regulatory purposes by the Agency. PERFUM also uses other Agency systems such as PCRAMMET. Please recommend any parameters that should be altered to optimize the manner that they are used in PERFUM? Does the panel agree with the manner in which the receptor grid was developed, and if not, please provide suggestions for improving this approach?
ISCST3, as integrated into PERFUM, was run assuming rural, flat terrain which would be typical of treated farm fields but might not be typical of surrounding residential areas. Does the panel concur with this approach? What are the implications of such an approach? What improvements can be made to this approach? ISCST3, as integrated into PERFUM, was run in regulatory mode which includes the use of the "calms" processing routine. Does the panel concur with this approach? If not, please suggest a suitable alternative?

<u>Critical Element 3: Results</u>

Question 6: Soil fumigants can be used in different regions of country under different conditions and they can be applied with a variety of equipment. Please comment on whether the methodologies in PERFUM can be applied generically in order to assess a wide variety of fumigant uses? What considerations with regard to data needs and model inputs should be considered for such an effort?

Question 7: Please comment on whether PERFUM adequately identifies and quantifies airborne concentrations of soil fumigants that have migrated from treated fields to sensitive receptors? The Agency is particularly concerned about air concentrations in the upper ends of the distribution. Are these results presented in a clear and concise manner that would allow for appropriate characterization of exposures that could occur at such levels? The PERFUM model calculates the concentration distributions both in all directions and for only the maximum concentration direction. Can the panel comment on how accurately the model approximates both of these distributions?

Question 8: A sensitivity/uncertainty analysis has been conducted and is described in the PERFUM background document. What types, if any, of additional contribution/sensitivity analyses are recommended by the panel to be the most useful in making scientifically sound, regulatory decisions? What should be routinely reported as part of a PERFUM assessment with respect to inputs and outputs? Are there certain tables and graphs that should be reported? What types of further evaluation steps does the panel recommend for PERFUM?