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**HSM-05014**

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SUBJECT: INTERIM STATEWIDE CAPS ANALYSIS FOR 1,3-DICHLOROPROPENE

## Summary

The Soil Fumigant Exposure Assessment ([SOFEA] V1. dated December 8, 2004) Tool was used to estimate upper- and lower-bounds for the 95th percentile long-term air concentration from a central 3x3 township area that, along with the surrounding 16 townships (a total area of 5x5 townships), were all set to an adjusted use level of 90,250 lbs 1,3-dichloropropene (1,3-d) per township-year. Modeled use patterns were based on statewide historical use from 2001–2003. Meteorological data consisted of five years from Ventura and five years from Merced. A simulation strategy consisted of estimating upper- and lower-bound concentration distributions. Upper- and lower-bound cumulative concentration distributions were used as input to the HEE5CB exposure model. A high mobility assumption was used. The resulting 95th percentile risks were between +32% and +60% higher than the reference level of 1E-5. Using upper- and lower-bound cumulative frequency distributions of risk for both males and females indicated that 1E-5 corresponded to about the 86th percentile.

## Background

The Department of Pesticide Regulation (DPR) has since 1994 imposed a limit on the total amount of 1,3-d that can be applied each year in any township. The purpose of this township cap is to manage cancer risk potentially associated with long-term inhalation exposure to 1,3-d. The cap was set at 90,250 adjusted pounds of active ingredient per township-year (the term "adjusted" refers to adjustment factors that are referenced in 1,3-d permit conditions and are used to multiply actual pounds of 1,3-d applied to account for flux differences between different application methods). This cap level of 90,250 adjusted pounds was set before sophisticated modeling approaches were available to assess the risk associated with different levels of 1,3-d use.

Two relevant modeling tools are now available: SOFEA and High End Exposure V5 Crystal Ball (HEE5CB). The former is a product of Dow AgroSciences (DAS) and is still being developed. It creates control files for a U. S. Environmental Protection Agency (U.S. EPA) Model, Industrial Complex Short Term (ISCST3) (U. S. EPA 1995). SOFEA then runs the ISCST3 model and processes the output from the ISCST3 model. The ISCST3 model is a special version that DPR modified to allow for the specification of buffer zones which exclude source contribution to receptors when both source and receptor are within the buffer zone (Johnson 2001a). The purpose
of this modification was so emulate the reality of fumigant applications which in many cases require buffer zones surrounding the field to keep people off of the field and away from the field for a time following application. Without this modification, ISCST3 calculates source contributions to on-field receptors. This special version of ISCST3 has been designated as ISCST3R.

HEE5CB is an exposure model that uses Monte Carlo sampling to simulate lifetime inhalation exposures to an airborne toxicant (Sanborn and Powell 1994, Powell 2005, and Johnson 2005d). Output from SOFEA consists of cumulative frequency distributions of long-term average air concentrations of the toxicant. This output is used as input to HEE5CB. The output from HEE5CB is a cumulative frequency distribution of lifetime average daily exposures to the toxicant. Cancer risk is then estimated by multiplying selected percentiles of the exposure distribution by a cancer potency factor.

The purpose of the analysis reported in this memorandum is to use the new modeling tools to estimate lifetime cancer risk associated with 1,3-d use at the township cap level of 90,250 adjusted pounds per year. This analysis used SOFEA to model long-term average air concentrations in a 5x5 township area in which the total cap amount of 90,250 adjusted pounds is applied in each of the townships each year. Although there is no actual area in California where 1,3-d is used so intensively in 25 contiguous townships, the modeling uses spatial and temporal patterns of applications in those townships where 1,3-d is used, applying them to all 25 modeled townships.

We are calling this an interim analysis for two reasons:

1. The results of the analysis are intended to be applicable statewide. However, due to limitations of time and resources, this work only used meteorology from two stations. Eventually, meteorology from more stations should be included.
2. The SOFEA model is still being developed by DAS. We have conducted in-depth reviews of previous and current versions of SOFEA and believe that it can be provide realistic estimates of long-term air concentrations. However, as this memorandum will discuss, SOFEA still has some problems, which seem to arise with multi-year runs. Because of this uncertainty, we believe the term “interim” is appropriate.

**Purpose**

To determine the relationship between the township cap level and lifetime cancer risk to residents.

**Methods**

The general methodology to use SOFEA consists of: (1) organizing and evaluating 1,3-d use data, (2) using the historical 1,3-d use data to input frequency distributions into SOFEA (application date, application rate, field size, and depth of application), (3) inputting section weight factors which reflect historical use patterns within each township, (4) setting flux functions, (5) setting township use limits, and (6) running SOFEA and checking for reasonableness of output, and correctness of modeling. The flux functions (4) have already been input into SOFEA. The other steps will be described in this memorandum.

Although SOFEA places 1,3-d applications in all 25 townships, only the concentrations in the central 3x3 township area are measured and output by the model. The central 3x3 township area is surrounded by a border of townships all at the township cap use level in order to mitigate edge effects in the simulation.

The SOFEA output, consisting of a cumulative frequency distribution of long-term air concentrations in the central 3x3 townships, is used as input to HEE5CB. HEE5CB has the ability to sample from two air concentration distributions, which allows modeling different levels of mobility of the population. HEE5CB has been run previously with low- and moderate-mobility assumptions; low mobility means that residents are assumed to spend their entire 70-year lifetimes within the single central township of the modeled area; moderate mobility means residents are assumed to spend their lifetimes within the central 3x3 township area, but to reside in (and therefore spend the greater part of time in) the one central township. In the current analysis, a “high-mobility” assumption was used. Residents are assumed to spend their lifetimes within the central 3x3 township area, and may reside anywhere within that area.

*Data editing prior to use*

We received a file with 1,3-d use information (Crop Data Management System) from 1999–2003 from Ian Wesenbeeck. We used this data to construct statewide probability distributions for 1,3-d use. Data was sorted by rate. There were 8065 records. Records with extremely low rates (<2 gallons/acre) were discarded (n=10). There was one clear error amongst these. It was dated June 9, 2000, and showed an application to 980100 acres of broccoli in Monterey. There were five records with rates > 50 gallons/acre. It appeared that the rate of application was off by

Table 1. Five data records with application rate reduced by factor of ten.

| Date | County | Gallons | Erroneous Gallons per Acre | Gallons per Acre - Adjusted | Total pounds applied, active ingredient | Pounds active ingredient per gallon | Crop | Product |
|---|---|---|---|---|---|---|---|---|
| 5/13/2003 | Santa Cruz | 10 | 70 | 7 | 689.3 | 0.98475 | BRUSSELS SPRTS | TELONE II |
| 11/18/2003 | Tulare | 6 | 155 | 15.5 | 915.8 | 0.98475 | PLUMS | TELONE II |
| 11/15/2002 | Stanislaus | 7 | 197 | 19.7 | 1358.0 | 0.98475 | ALMONDS | |
| 2/13/2003 | Stanislaus | 6 | 227 | 22.7 | 1341.2 | 0.98475 | PEACHES | TELONE II |
| 11/17/2000 | Tulare | 3.37 | 332.29 | 33.229 | 1102.7 | 0.98475 | PEACHES | TELONE II |

a factor of ten. These rates were all divided by ten and the pounds of 1,3-d applied was recalculated using 0.98475 pounds 1,3-d per gallon of formulated product (Table 1).

There were 25 records that had no crop, rate, acreage, or formulation listed. There was one record, which listed “airfield” as the crop. These were discarded. In summary, 36 records were discarded and the rate of application on 5 records was modified.

We examined the data that was left after the adjustments listed above. There were several crops that showed increasing use trends over the five-year period. In order to get distributions reflecting the more current data, we eliminated 1999 and 2000 data. Another, somewhat artificial reason for eliminating 1999 and 2000 data was that Crystal Ball imposes a 1440 item limit on single-item custom frequency distributions. When inputting data into Crystal Ball, it is difficult to accomplish when there are more than 1440 records. Eliminating 1999 and 2000-year records left 5706 records.

The next step was grouping each crop into one of the five codes allowed by SOFEA: TV, FC, SB, PP, and NC. While the acronyms are suggestive of specific crops (tree and vine, field crop, strawberries, pre-plant, and nursery crops), the actual meaning of these five “crop types” depends on how the Crop Data Management System data is grouped and mapped into these five “crop types”. Except for TV, these crop types are treated as annual crops. TV is treated differently in that a TV source is not retreated, whereas in multi-year runs the annual crop fields may get retreated. These groupings are defined for the purpose of generating probability distributions, which are utilized in SOFEA0501 to generate sources. In defining these groups there were several goals and decisions: (1) we tried to get the number of records in each group below 1440, (2) we put root crops into PP, plus noncrop areas, (3) we took almonds out of TV and put them into NC in order to get TV below 1440, (4) Into SB we put crops that had significant percentage of drip irrigation applications, (5) TV was all tree and vine, except almonds, and (6) Into FC we put everything else.

Table 2 was extracted from Excel. The worksheet function “vlookup” was used to add a column onto the database, which translates each crop entry according to Table 2.

Table 2. Category code definitions for crops.

| Crop | Cat | Crop | Cat | Crop | Cat | Crop | Cat |
|---|---|---|---|---|---|---|---|
| ALDER,EUROPEAN | TV | CHERRIES, SAND | TV | MELONS | FC | RADISHES | PP |
| ALFALFA | FC | CHERRIES-SWEET | TV | MUSTARD | FC | RASPBERRIES | TV |
| ALMONDS | NC | CHERRY,BLACK | TV | NAPA CABBAGE | FC | RED BEETS | FC |
| APPLES | TV | CITRUS HYBRIDS | TV | NECTARINES | TV | ROSES | FC |
| APRICOTS | TV | CITRUS(NURSERY | TV | NON CROP AREAS | PP | RYEGRASS | FC |
| ARTICHOKES | FC | CITRUS-ORN | TV | NURSERIES | FC | SPINACH | FC |
| ASPARAGUS | FC | CONIFER NURSRY | TV | NURSERY STOCK | FC | SQUASH (SUMMR) | FC |
| AVOCADOS | TV | CORN/SWEET | FC | ONIONS (DRY) | FC | STRAWBERRIES | SB |
| BASIL | FC | COTTON | FC | ONIONS (SEED) | FC | STRAWBERRY,BCH | SB |
| BEANS (DRY) | FC | CUCUMBERS | FC | ONIONS,SPANISH | FC | SUGAR BEETS | PP |
| BEANS (LIMA DR | FC | EGGPLANT | FC | ORANGES (NAVEL | TV | SWEET POTATOES | PP |
| BEDDING PLANTS | FC | FALLOW GROUND | FC | ORANGES(SWEET) | TV | TOMATO SEEDED | FC |
| BEETS (TABLE) | PP | FLOWERS | SB | ORANGES(VALEN) | TV | TOMATO TRSPLT | FC |
| BEETS (TOP) | PP | GRAPES (FRESH) | TV | ORNAMENTALS | FC | TOMATOES FRESH | FC |
| BITTER MELON | FC | GRAPES (RAISN) | TV | PARSLEY | FC | TURFGRASS | FC |
| BLACKBERRIES | TV | GRAPES (WINE) | TV | PEACHES | TV | Unknown | FC |
| BROCCOFLOWER | FC | HONEYDEW MELON | SB | PEARS | TV | WALNUT (ORN) | TV |
| BROCCOLI | FC | LEMONS | TV | PEPPERS (BELL) | SB | WALNUTS (BLCK) | TV |
| BRUSSELS SPRTS | SB | LETTUCE (HEAD) | FC | PEPPERS, CHILE | SB | WALNUTS (ENGL) | TV |
| CABBAGE | FC | LETTUCE (LEAF) | FC | PEPPERS-NO BEL | SB | WATERMELONS | SB |
| CANTALOUPE | FC | LETTUCE,ROMAIN | FC | PLUMS | TV | YAMS | PP |
| CARROTS | PP | LILY | FC | POTATOES | PP | | |
| CAULIFLOWER | FC | MAHALEB CHERRY | TV | PRUNES | TV | | |
| CELERY | FC | MANDARIN/ORANG | TV | PUMPKINS | FC | | |

The next step was to sort the database by category, then by date of application. The starting and ending rows for each of the five “crop” sections were noted and used for defining the custom distributions in Crystal Ball. Acreages and pounds were converted to hectares and kilograms before inputting into the Crystal Ball distributions. Application date was converted to Julian date using a macro, val2jul (listed in Appendix), and input into Crystal Ball distributions.

Table 3 lists the various breakdowns by count of records of the percentages used to create various fields in the “PDF Parameters” worksheet. This is the name of an important input worksheet in SOFEA. The “PDF” refers to probability distribution functions, which are input here for use with Crystal Ball. The label requires all drip applications to be tarped. The tarping algorithm appears to place a limit of 65% on the maximum amount of off-gassing regardless of drip or shank. While this would seem reasonable for drip, we are not sure that it applies to shank.

Table 3. Percentages used in creating various fields in PDF worksheet.

| Crop Category | Percent Drip Applications | Percent Shank Applications | Shank applications deep/shallow split: Percent of shank at 18 inches | Shank applications deep/shallow split: Percent of shank at 12 inches |
|---|---|---|---|---|
| FC | 3.0 | 97.0 | 71.3 | 28.7 |
| NC | 0.0 | 100.0 | 99.2 | 0.8 |
| PP | 0.0 | 100.0 | 71.0 | 29.0 |
| SB | 51.3 | 48.7 | 22.8 | 77.2 |
| TV | 0.4 | 99.6 | 94.6 | 5.4 |

Therefore we defined 0% tarping for all but SB. And 100% tarping for the drip in SB. Note these percentages are by count of the database records, not by acreage.

We set the average elevation to zero and set the elevations of the 3x3 township area to zero.

*Section weights*

Section weights are assigned to sections within a township and influence the probability that sources will be located in that section. Historical use patterns clearly show that some sections receive higher use than others. Section weights had been computed for selected high use townships in Merced and Ventura (Powell 2002, 2004). In brief these weights were determined by (1) obtaining the crop list in Ventura and Merced for crops where 1,3-d was utilized, (2) determining acreages for any pesticide application to those crops, and (3) eliminating redundant acreage as determined by the combination of grower identification and site-location identification. Section weights are the normalized acreage values, such that the sum equals 1.0 within a township. There were five townships in Ventura and six townships in Merced where 1,3-d use was high and for which we had the section weights. For each of the 11 townships, there was one set of weights for annuals and one set for perennials. The resulting

Table 4. Twenty two files containing Merced and Ventura section weights for annual (*a.csv) and Perennial (*p.csv) township weights.

```
06/14/2005  01:58p      252 01n21wa.csv
06/14/2005  01:58p      150 01n21wp.csv
06/14/2005  01:58p      184 01n22wa.csv
06/14/2005  01:59p       31 01n22wp.csv
06/14/2005  01:59p      162 02n20wa.csv
06/13/2005  01:55p      255 02n20wp.csv
06/14/2005  01:59p      164 02n21wa.csv
06/14/2005  02:00p      213 02n21wp.csv
06/14/2005  02:00p      268 02n22wa.csv
06/14/2005  02:00p      173 02n22wp.csv
06/14/2005  02:01p       84 06s10ea.csv
06/14/2005  02:01p      201 06s10ep.csv
06/14/2005  02:01p      129 06s11ea.csv
06/14/2005  02:02p      252 06s11ep.csv
06/14/2005  02:02p      114 06s12ea.csv
06/14/2005  02:05p      235 06s12ep.csv
06/14/2005  02:06p       67 07s10ea.csv
06/14/2005  02:06p       47 07s10ep.csv
06/14/2005  02:06p      128 07s11ea.csv
06/14/2005  02:07p      170 07s11ep.csv
06/14/2005  02:07p      136 07s12ea.csv
06/14/2005  02:08p      207 07s12ep.csv
```

twenty-two file names in Table 4 describe the townships utilized.

Each file in Table 4 contained a comma-separated list consisting of section number (1-36), comma, and a fractional number representing the fractional acreage of crops, which may receive 1,3-d treatment in the township. Nonzero sections only were listed in each file.

Figure 1. Section numbering and example weights shown undergoing 90 degree rotation.

| | | | | | |
|---|---|---|---|---|---|
| 6 | 5 | 4 | 3 | 2 | 1 |
| 7 | 8 | 9 | 10 | 11 | 12 |
| 18 | 17 | 16 | 15 | 14 | 13 |
| 19 | 20 | 21 | 22 | 23 | 24 |
| 30 | 29 | 28 | 27 | 26 | 25 |
| 31 | 32 | 33 | 34 | 35 | 36 |

| | | | | | |
|---|---|---|---|---|---|
| 31 | 30 | 19 | 18 | 7 | 6 |
| 32 | 29 | 20 | 17 | 8 | 5 |
| 33 | 28 | 21 | 16 | 9 | 4 |
| 34 | 27 | 22 | 15 | 10 | 3 |
| 35 | 26 | 23 | 14 | 11 | 2 |
| 36 | 25 | 24 | 13 | 12 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| 0.12 | | 0.04 | 0.31 | 0.25 | 0.20 |
| | | | | 0.08 | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | 0.12 |
| | | | | | |
| | | | | | 0.04 |
| | | | | | 0.31 |
| | | | | 0.08 | 0.25 |
| | | | | | 0.20 |

In order to utilize these weights for the model in a representative way, we created a FORTRAN program, MAK3X3V3.FOR, which randomly selected 9 of the 11 annual files (with replacement) and the corresponding 9 perennial files. Each file consisted of a list of sections and the corresponding weights. These weights were entered into a matrix, which followed the conventional section numbering system (Figure 1). Before putting the weights into an 18x18 matrix for reading into SOFEA, each township-weight matrix was randomly rotated either 0,90,180 or 270 degrees (Figure 1). The rotation was done to avoid human bias in setting up the section weights and to provide some perturbation of the weights, without destroying the structure. In order to preserve possible correlation between the annual and perennial weight matrices, the perennial matrix was rotated by the same amount as the selected annual matrix. MAK3X3V3.FOR then wrote out a comma-separated file of 18 rows of 18 numbers, representing a 3x3 township area for annual and perennial weights. These values were then read into SOFEA0501 for use in modeling.

*Miscellaneous settings*

We set the drip start hour to ten and shank to eight to match what was in the flux file. We set all elevations to zero and set the Terrain flag in PDF to FLAT. We manually deleted leftover rows of numbers in Field_Sz_Opt1, Field_Info_1, Misc, 24hr_max, Chronic, 24hr_Summary, Run_avg_twn. We set population to zero and made all land agriculture capable. Township weights were set to 1.0 for all 25 townships. The township weight is a factor used to multiply by the township cap amount in order to investigate the impact of different township caps on the

concentration distributions. In this case, the interest was in determining the relationship between the township cap of 90,250 and concentration and risk. Therefore, all township weight factors were set to 1.0. The 1.0 for the central 9 was set in Twn_mass_wt. The 1.0 for the external 16 townships was set in Twn_mass_Wt_Ext. We set the section weights for the external 16 townships all to 1/36 in Twn_mass_Wt_Ext. In theory SOFEA has the capability to simulate townships outside of the 25 township center. All of the section weights in townships external to the 25 central townships were set to zero. Crop percent was set to 14, 24, 5, 18, and 39 for TV, FC, NC, SB, and PP in both worksheets: PDF and Crop%_Ext (Loop 1 - for all townships in Loop 1). Township allocation (i.e. the township cap) in PDF worksheet was set to 40937 kg.

Table 5. Realized crop percentages. The target percentages were input into the control file. The results stem from four runs numbered J1206-J1209.

| | J1206 | J1207 | J1208 | J1209 | Mean | SD | Target |
|---|---|---|---|---|---|---|---|
| FC | 27.6 | 29.6 | 27.1 | 28.1 | 28.1 | 1.1 | 24.0 |
| NC | 0.0 | 0.3 | 0.7 | 0.7 | 0.4 | 0.3 | 5.0 |
| PP | 41.5 | 38.4 | 45.5 | 37.9 | 40.8 | 3.5 | 39.0 |
| SB | 16.4 | 19.5 | 14.4 | 17.2 | 16.9 | 2.1 | 18.0 |
| TV | 14.5 | 12.2 | 12.3 | 16.1 | 13.8 | 1.9 | 14.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | | 100.0 |

*Verification of crop percentages*

Crop percentages were set in the PDF Parameters worksheet based on acreage. A first step was to simulate one-year time intervals and then to verify that the SOFEA-realized crop percentages approximated the target percentages reasonably well. This turned out to be OK. Table 5 indicated that realized crop percentages, while varying from one simulation to the next, were reasonably close to the input crop percentages. NC was typically short. The other percentages were reasonably close.

Table 6. Realized crop percentages. The target percentages were input into the control file. The results stem from four runs numbered J1210 to J1213, each having a different set of section weights in the central 3x3.

| | J1210 | J1211 | J1212 | J1213 | Mean | SD | Target |
|---|---|---|---|---|---|---|---|
| FC | 22.4 | 21.2 | 24.5 | 24.7 | 23.2 | 1.7 | 24.0 |
| NC | 0.1 | 0.5 | 0.2 | 0.0 | 0.2 | 0.2 | 5.0 |
| PP | 47.6 | 47.0 | 40.2 | 43.8 | 44.7 | 3.4 | 39.0 |
| SB | 17.1 | 17.6 | 23.2 | 18.3 | 19.0 | 2.8 | 18.0 |
| TV | 12.8 | 13.8 | 11.9 | 13.2 | 12.9 | 0.8 | 14.0 |
| Total | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | | 100.0 |

*Vary the section weights*

We created five different sets of section weights, using the MAK3X3V3 program. We performed a one-year simulation using each set of section weights. We utilized weight set one for the results in Table 5. For Table 6, we conducted four runs, J1210-J1213, using, respectively, section weight sets 002-005. Thus the weights in these four runs were different from each other and different from those used in Table 5. The mean values differ some from the expected (target) values and from the corresponding values found in Table 5. Overall, however, they appear to be fairly similar, which suggests that the year-to-year variability of crop percentages induced by randomized yearly recreation of sources is about the same as the year-to-year variability induced by both randomized yearly recreation of sources and changing the central 3x3 section weight structure. Because there were 11 different sets of section weights, and 9 townships to fill, there is substantial commonality between the 5 differing sets of section weights. Thus it is not particularly important with respect to crop percentages, which set of section weights were utilized for further simulation.

The next step was to extend the simulations to two years and again check the crop percentages and, new to this phase, check the repeat field percentages. In the course of making two-year runs, we discovered that SOFEA was no longer choosing a fresh meteorological year for the second simulation year. It appeared to be stuck on whatever year was listed in the original PDF sheet. Therefore, we abandoned making these two-year runs. We will describe a modified simulation strategy below.

*Create a single series of multistation weather files*

In order to run the program over multiple weather stations it was convenient to combine the Merced and Ventura weather into what would appear to SOFEA to be a single weather station. Although there were other stations available, we have not had time to examine that data. Therefore, we combined only Merced and Ventura for this interim analysis. Each county data set consisted of five years of hourly meteorological data, primarily based on selected stations from the California Irrigation Management Information System. A full discussion of the origin of these meteorological data sets can be found in Johnson (2001b). To combine the data it was necessary to change the header line in each one-year weather file, change the name of the file, change the year in the header record and change the year in the met data records correspondingly. To accomplish this task we wrote TRANSFORM.FOR, which requests the old and new changes and copies over the data with the changes. It is important to note that no actual met data is changed, only the header and year information. This operation essentially tricks SOFEA into thinking that there is a single station with ten years of data. It was necessary to pay attention to leap years. Therefore, the Ventura 1996 year had to correspond to the CAL22000 year, just as the Merced 1996 year was redesignated as the CAL21996 year.

When we started making simulation runs using the meteorological file scheme listed in Table 7, we discovered several new problems with SOFEA. These problems included: (1) incorrect

formatting of the meteorological data files, (2) (as mentioned above) failure of SOFEA to randomly select new meteorological year (i.e. would use same meteorological data file every year), (3) incorrectly handling year 2000 in building the flux files, leading to error in running ISCST3R, and (4) the realized repeat field application percentages were not adequately representing the expected run lengths of applications to the same field (Johnson 2005abc).

We solved problem number one by writing a FORTRAN program to reformat the meteorological data. The problem evidently occurred in the DAS processing of data, which we had provided them and in which DAS has changed the formatting of the data sets. We could not solve problem number two. We solved problem number three by prepending, instead of appending the Ventura met files to the Merced data files. The resulting table is similar to Table 7, except Ventura is assigned to the years 1988–1992, (Table 8). For problem number four, we proposed that instead of a direct simulation, a strategy of bounding the value of interest should be used.

Table 7. List of met data changes in order to join Ventura and Merced data into a single station. This listing was later abandoned.

| original file | renamed file | other changes |
|---|---|---|
| merc1993.met | cal21993.met | header change 99056 to 99999 |
| merc1994.met | cal21994.met | " |
| merc1995.met | cal21995.met | " |
| merc1996.met | cal21996.met | " |
| merc1997.met | cal21997.met | " |
| vent1999.met | cal21998.met | header change 99101 to 99999, 1999 to 1998, data change 99 (year field) to 98 (year field) |
| vent1995.met | cal21999.met | header change 99101 to 99999, 1995 to 1999, data change 95 (year field) to 99 (year field) |
| vent1996.met | cal22000.met | header change 99101 to 99999, 1996 to 2000, data change 96 to 00 |
| vent1997.met | cal22001.met | header change 99101 to 99999, 1997 to 2001, data change 97 to 01 |
| vent1998.met | cal22002.met | header change 99101 to 99999, 1998 to 2002, data change 98 to 02 |

Our simulation strategy in light of the problems outlined above was to bracket the values of interest with a lower and upper bound. A lower bound could be determined by simulating each weather year separately (but with the control file otherwise the same). These ten years of simulations would be combined by averaging the ten concentrations at each receptor. This method of finding the average is equivalent to what SOFEA would calculate were it to run for ten years and use each weather year once. However, it is also equivalent to having zero

Table 8. List of met header and date changes in order to join Ventura and Merced data into a single station and *prepending* Ventura data files.

| original file | renamed file | other changes |
|---|---|---|
| merc1993.mxt | cal21993.mxt | header change 99056 to 99999 |
| merc1994.mxt | cal21994.mxt | " |
| merc1995.mxt | cal21995.mxt | " |
| merc1996.mxt | cal21996.mxt | " |
| merc1997.mxt | cal21997.mxt | " |
| vent1995.mxt | cal21988.mxt | header change 99101 to 99999, 1995 to 1988, data change 95 (year field) to 88 (year field), I duplicated feb 28 for feb 29 since 1995 is not a leap year, but 1988 is a leap year and the programs expect it |
| vent1997.mxt | cal21989.mxt | header change 99101 to 99999, 1997 to 1989, data change 97 (year field) to 89 (year field) |
| vent1998.mxt | cal21990.mxt | header change 99101 to 99999, 1998 to 1990, data change 98 to 90 |
| vent1999.mxt | cal21991.mxt | header change 99101 to 99999, 1999 to 1991, data change 99 to 91 |
| vent1996.mxt | cal21992.mxt | header change 99101 to 99999, 1996 to 1992, data change 96 to 92 |

repeat field applications. Repeat-field applications would increase the concentrations at the upper percentiles. Aside from section weight constraints, every simulation year would be independent from every other year. After finding the average at each receptor, then these receptor averages are combined to form a concentration distribution. This distribution would be a lower bound for the upper percentiles because repeat-field applications (which are nonexistent in these ten years of simulations) would tend to give even higher concentrations than when there are no repeat-field applications.

An upper-bound can be found using the same ten one-year simulations by averaging the distributions. At each percentile, the ten corresponding concentration measurements would be averaged. The spatial element is completely ignored in this averaging procedure. A single year of simulation is like having the same fields treated year after year with exactly the same weather. Therefore, the upper end of a concentration distribution which arises from a single year of simulation would be expected to be higher than the upper end of a concentration distribution which was based on multiple years of simulation in which half of the annual crop (i.e. not TV) fields moved around every year. By taking the average of the ten one-year distributions, we get an estimate of the concentration variability around the 95th percentile for this upper-bounding condition.

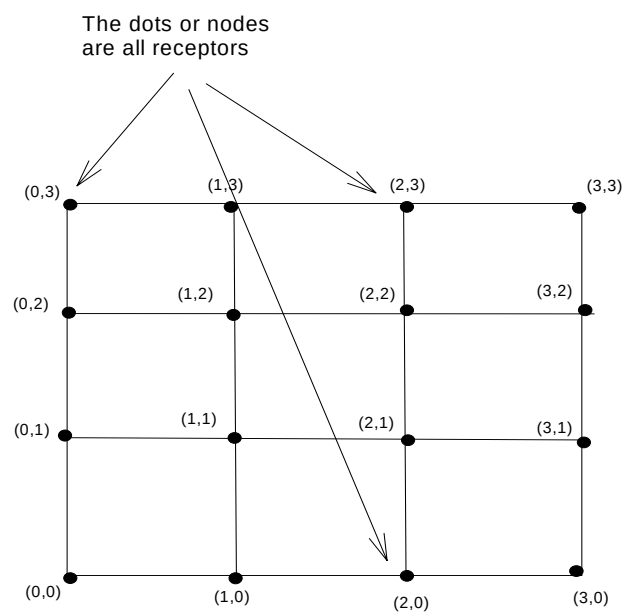


Figure 2. 16 receptor example

A possible objection to the upper-bound is that a simulation using the same ten years of meteorology, but having fixed sources each year instead of varying sources, would produce even higher concentrations than this supposed upper-bound. This issue was investigated and no statistically significant or practically significant differences were found between upper-bounds based on fixed-source simulations versus varying-source simulations in this scenario (Johnson 2005e).

To help understand these two ways of finding an average, we have created Figure 2. This figure depicts a small 4x4 grid of points, which totals 16 receptor positions. In the course of simulation, the model uses these location points to measure the atmospheric concentrations. Sources are fields, which are located through the grid as squares (not shown). We have created some artificial data, as though there were three, one-year simulations estimating concentrations at each receptor.

These artificial simulation results are depicted in Table 9. Three individual years of estimated concentrations are shown in the upper left portion of the table, along with the location of the corresponding receptor. The calculations to the right show the procedure for determining the receptor average and associated cumulative concentration distribution. First the average at each receptor over years is found. Then this set of concentrations is sorted and the cumulative percentile is determined. When sources move around from year to year, this method will yield lower concentrations at the upper percentiles. Over years each receptor may see high and low

Table 9. Artificial example of receptor averaging versus percentile averaging.

| | Concentration (ug/m3) | | |
|---|---|---|---|
| **Receptor** | **Year 1** | **Year 2** | **Year 3** |
| (0,0) | 1.1 | 1.5 | 1 |
| (1,0) | 0.9 | 1 | 0.2 |
| (2,0) | 0.2 | 0.2 | 0.7 |
| (3,0) | 0.1 | 0.2 | 0.5 |
| (0,1) | 0.9 | 0.5 | 0.2 |
| (1,1) | 1.4 | 1 | 1.2 |
| (2,1) | 0.5 | 0.4 | 0.5 |
| (3,1) | 0.1 | 0.1 | 0.2 |
| (0,2) | 0.4 | 0.6 | 0.5 |
| (1,2) | 0.6 | 0.5 | 0.2 |
| (2,2) | 0.8 | 0.5 | 0.2 |
| (3,2) | 0.1 | 0.2 | 1.3 |
| (0,3) | 0.2 | 0.2 | 1.3 |
| (1,3) | 0.2 | 0.3 | 0.5 |
| (2,3) | 0.3 | 0.3 | 0.3 |
| (3,3) | 0.3 | 0.1 | 0.2 |

**Average by Receptor**

| **Average By Receptor** |
|---|
| 1.2 |
| 0.7 |
| 0.4 |
| 0.3 |
| 0.5 |
| 1.2 |
| 0.5 |
| 0.1 |
| 0.5 |
| 0.4 |
| 0.5 |
| 0.5 |
| 0.6 |
| 0.3 |
| 0.3 |
| 0.2 |

| **(Sorted) Concentration (ug/m3)** | **Cumulative Percentile (%)** |
|---|---|
| 0.1 | 13 |
| 0.2 | 19 |
| 0.3 | 25 |
| 0.3 | 31 |
| 0.3 | 38 |
| 0.4 | 44 |
| 0.4 | 50 |
| 0.5 | 56 |
| 0.5 | 63 |
| 0.5 | 69 |
| 0.5 | 75 |
| 0.5 | 81 |
| 0.6 | 88 |
| 0.7 | 94 |
| 1.2 | 100 |
| 1.2 | 106 |

**Average by Percentile**

| (sorted) Year 1 | (sorted) Year 2 | (sorted) Year 3 |
|---|---|---|
| 0.1 | 0.1 | 0.2 |
| 0.1 | 0.1 | 0.2 |
| 0.1 | 0.2 | 0.2 |
| 0.2 | 0.2 | 0.2 |
| 0.2 | 0.2 | 0.2 |
| 0.2 | 0.2 | 0.2 |
| 0.3 | 0.3 | 0.3 |
| 0.3 | 0.3 | 0.5 |
| 0.4 | 0.4 | 0.5 |
| 0.5 | 0.5 | 0.5 |
| 0.6 | 0.5 | 0.5 |
| 0.8 | 0.5 | 0.7 |
| 0.9 | 0.6 | 1 |
| 0.9 | 1 | 1.2 |
| 1.1 | 1 | 1.3 |
| 1.4 | 1.5 | 1.3 |

| **Average Concentration at each percentile (ug/m3)** | **Cumulative Percentile (%)** |
|---|---|
| 0.1 | 6 |
| 0.1 | 13 |
| 0.2 | 19 |
| 0.2 | 25 |
| 0.2 | 31 |
| 0.2 | 38 |
| 0.3 | 44 |
| 0.4 | 50 |
| 0.4 | 56 |
| 0.5 | 63 |
| 0.5 | 69 |
| 0.7 | 75 |
| 0.8 | 81 |
| 1.0 | 88 |
| 1.1 | 94 |
| 1.4 | 100 |

concentrations, which reflect the moving around of the sources. For example, receptor (1,0) gets 0.9, 1.0, and 0.2. Thus in year three, this receptor saw a reduced concentration. When those concentrations are averaged together, the low year reduces the average.

In the percentile averaging procedure, higher concentrations tend to track with the higher concentrations, even though they may have occurred in different spatial locations. The lower left portion of Table 9 below the data matrix illustrates how percentile averages are found. Each year
of concentrations is sorted from lowest to highest. Each concentration at each percentile is then averaged. Consequently, higher concentrations are averaged with higher concentrations. The highest concentrations each year stay together in forming the average. In the example, these highest concentrations were 1.4, 1.5, and 1.3 along the bottom row of the lower left data table. Consequently, the highest percentile concentration under the "average by receptor" method is 1.2 compared to 1.4 under the "average by percentile" method.

In the case at hand, the "average by receptor" method (also sometimes called "spatial average") will be used as a lower-bound for the distribution because it reflects the "movement" of sources in relation to receptors from year to year, with no fields being repeat-treated. The "average by percentile" method will be used as an upper-bound for the distribution because in some sense it represents concentrations that would be higher than expected over the long term because it does not allow for "movement" of the sources. High concentrations are averaged with high concentrations regardless of their spatial location.

Since there were ten distinct meteorological years, we ran SOFEA once for each year. We used the section weighting scheme designated ann9.001 and per9.001. In order to get some perspective on the variability of the results, we ran another ten simulations using ann9.005 and per9.005, which was a different section weighting scheme as described above. The actual section weights are listed in the Appendix.

The simulations were run with "PDF parameters" as shown in the Appendix. The township caps were all set to 1.0, equivalent to an adjusted 90,250 lbs of active ingredient. Since the units in the model are kilograms, this was converted to 40,937 kg. (1lb=0.4536kg). Sources were distributed according to section weights within the central 3x3 township area, and randomly on the outside township edge (16 townships surrounding the central 3x3 townships). Since the modeling was for one year, the PDF parameters sheet covered most of the key input values that needed specification.

We wrote MAK10.FOR to calculate the receptor averages. When making multi-year runs with SOFEA, SOFEA normally performs this chore. However, since SOFEA was not changing the meteorological year, we intended to conduct single-year simulations and needed to find these averages with our own programming from these separate simulations. The MAK10.FOR

program relied upon a series of text files extracted from the two sets of runs, J1228-J1237 and J1244-J1253, which consisted of the x and y receptor location and the one year concentration average at that point. These text files were produced by a visual basic macro, OUTAR, shown in the Appendix.

A key product of a SOFEA simulation is the cumulative frequency distribution of long-term air concentrations. In order to assess the exposure with such a distribution, the distribution is entered into an exposure simulation model, HEE5CB (Sanborn and Powell 1994, Powell 2005, Johnson 2005d). HEE5CB utilizes a Monte Carlo approach to sampling from the cumulative distribution of air concentrations, in conjunction with sampling from distributions of body weights, breathing rates and other relevant parameters to produce a distribution of lifetime exposures. These exposures are, like the concentrations, in the form of cumulative frequency distributions. While the overall distributions are of interest, Gosselin (2001) indicated that DPR regulatory effort regarding 1,3-d would be directed towards the 95th percentile exposure level. To convert exposure to risk requires simple multiplication by the upper-bound potency factor of 0.000055 kg-day/ug (Reed 2001).

A technical issue in using the HEE5CB model with output from the "receptor-averaged" distributions concerns limitations on Crystal Ball entries. Crystal Ball will not accept more than about 300 pairs of points to define a cumulative distribution. The receptor-averaged distributions contained 11,664 pairs of points (36x36x9). To accommodate this limitation we wrote a Visual Basic macro, sub getsmaller, which sampled every 54th point, to produce an equivalent distribution with only 216 pairs of points (216x54=11664). This number of pairs is an acceptable size for use in Crystal Ball. The macro, getsmaller, is listed in the Appendix. We verified the correct operation of this subroutine by comparing graphs, one with the full data set to one with the subset of data. The graphs were similar.

To carry the SOFEA results all the way through, we ran the HEE5CB exposure assessment using as input: (1) the "receptor-averaged" distributions (the lower bound) and (2) the "percentile-averaged" distribution (the upper-bound). We did these runs for both sets of ten one-year runs. After some initial runs on HEE5CB, we determined that HEE5CB runs of 50000 iterations gave results stable to 2 decimal places. All reported results here from HEE5CB are based on runs of 50000 trials. We used a "high mobility" assumption. This assumption meant that a single concentration distribution from the 3x3 township area was used to sample from. This was interpreted as equivalent to all activities taking place anywhere within the central nine township area. To obtain the exposure distribution, we added 100 cells to HEE5CB containing the Crystal Ball worksheet function: "=CB.GetForePercentFN(A,B)", where A=a percentile, B=the forecast distribution cell. We used the forecast distribution from HEE5CB labeled "0-70 years" for "male" and "female" (G486, H486 in HEE5CB).

**Results**

The air concentration distributions based on the receptor-averaging method (spatial) were intended to be lower bounds on the estimate. These levels produced 95th percentile concentrations of 0.86 and 0.84 ug/m3 for the two groups of simulations (Table 10). As a reminder, these two groups differed in the section weights used to assign sources. The upper-bound concentration estimates were 0.97 and 0.94 ug/m$^3$ (Table 10). These estimates should be an upper bound for the "true" estimate because they consist of percentile averages of single-year simulations.

**Table 10. Summary of 95th percentile statistics for air concentration distributions and exposure distributions. Numbers in parentheses are standard deviations. J1228-J1237 and J1244-J1253 run series correspond to different section weightings ANN9.001/PER9.001 and ANN9.005/PER9.005, respectively.**

| | | J1228-J1237 | | J1244-J1253 | |
|---|---|---|---|---|---|
| | | Percentile Average | Spatial Average | Percentile Average | Spatial Average |
| Concentration (ug/m3) | | 0.97 (0.10) | 0.86 | 0.94 (0.07) | 0.84 |
| Exposure (ug/kg*day) | Male | 0.29 | 0.25 | 0.29 | 0.24 |
| | Female | 0.28 | 0.24 | 0.28 | 0.23 |
| Risk | Male | 1.60E-05 | 1.35E-05 | 1.59E-05 | 1.32E-05 |
| | Female | 1.50E-05 | 1.32E-05 | 1.51E-05 | 1.29E-05 |

Figures 3 and 4 present the concentration distributions and zoomed-in views of the upper percentiles for the two sets of runs. Below the 94th percentile, the lines are fairly coincident. The lines begin to diverge at about the 96th percentile and above. This was true for both sets of concentration distributions. Thus, the main distinguishing impact of multiple years of weather, and switching on and off of sources occurs primarily at the 96th percentile and above. The second set of simulations gave results that were very similar to the first set of simulations. Therefore, the rotation within the central 3x3 township matrix of the section weights did not much affect the results.

The curves in Figure 5 were based on the second set of concentration runs (J1244-J1253) and were very similar to the results from the first set. Consequently, the figure of results from the first set are omitted. The cumulative distribution of exposures was similar in shape to the cumulative distribution of concentrations.

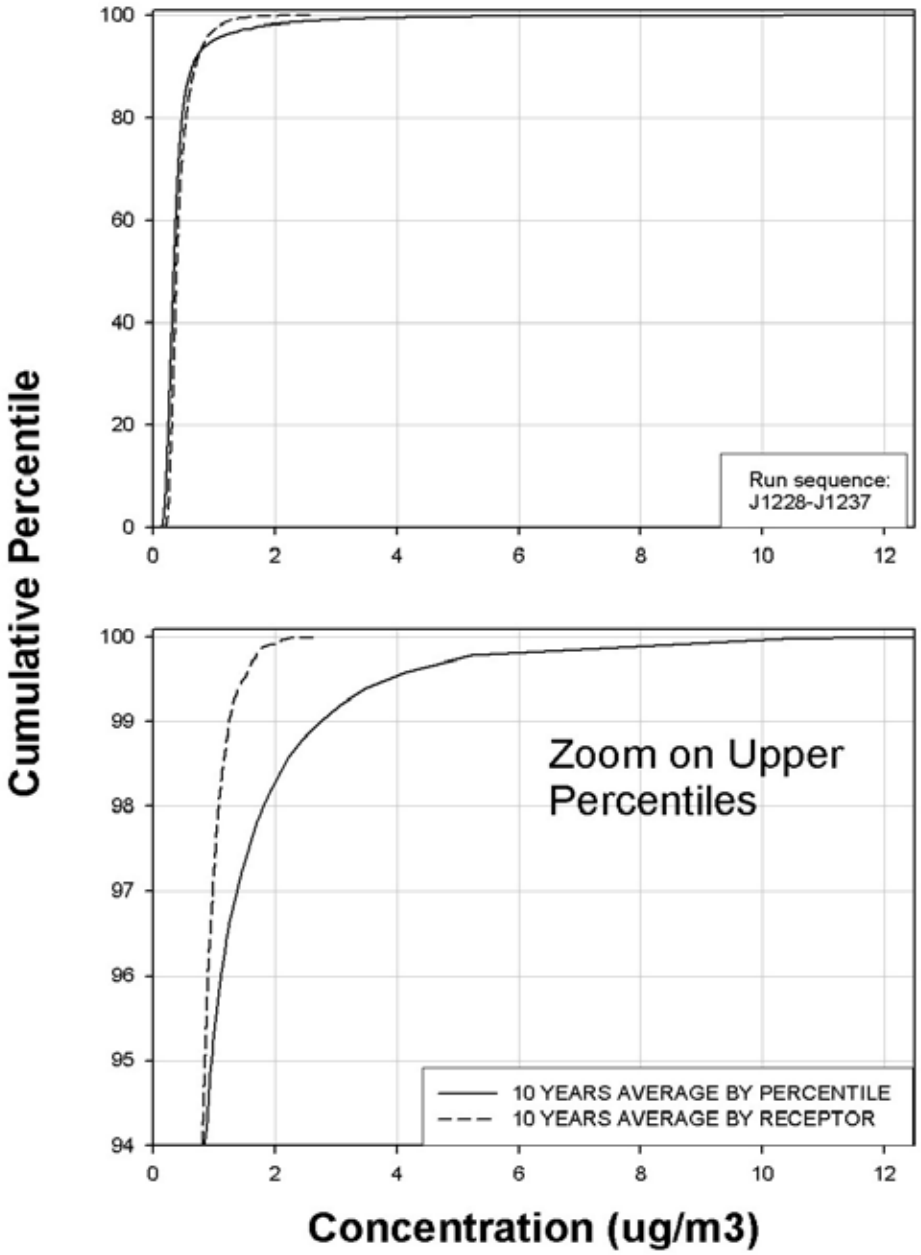


**Figure 3. Concentration distribution from first set of 10 runs: J1228-J1237.**

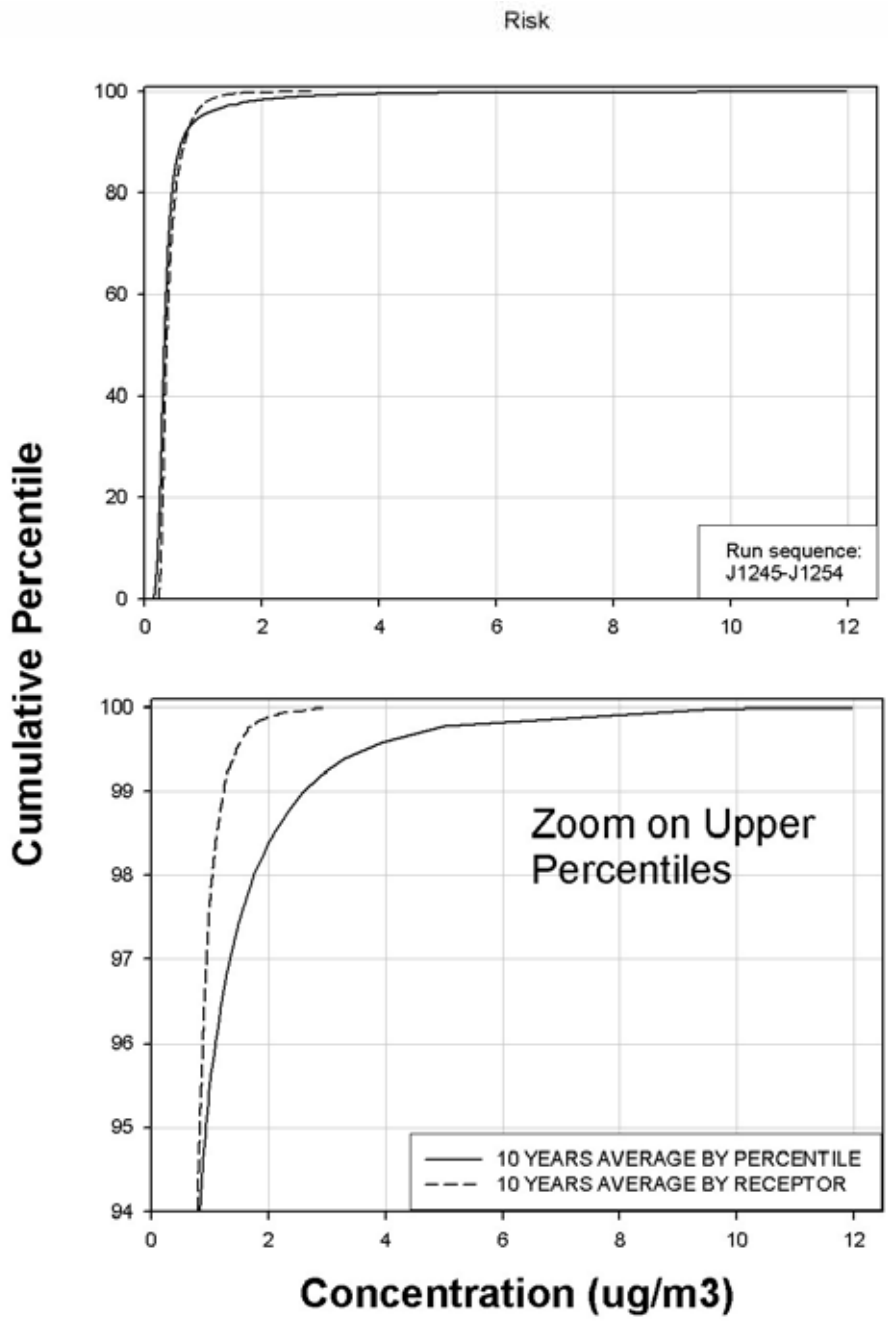


**Figure 4. Concentration distribution from second set of runs: J1245-J1254.**

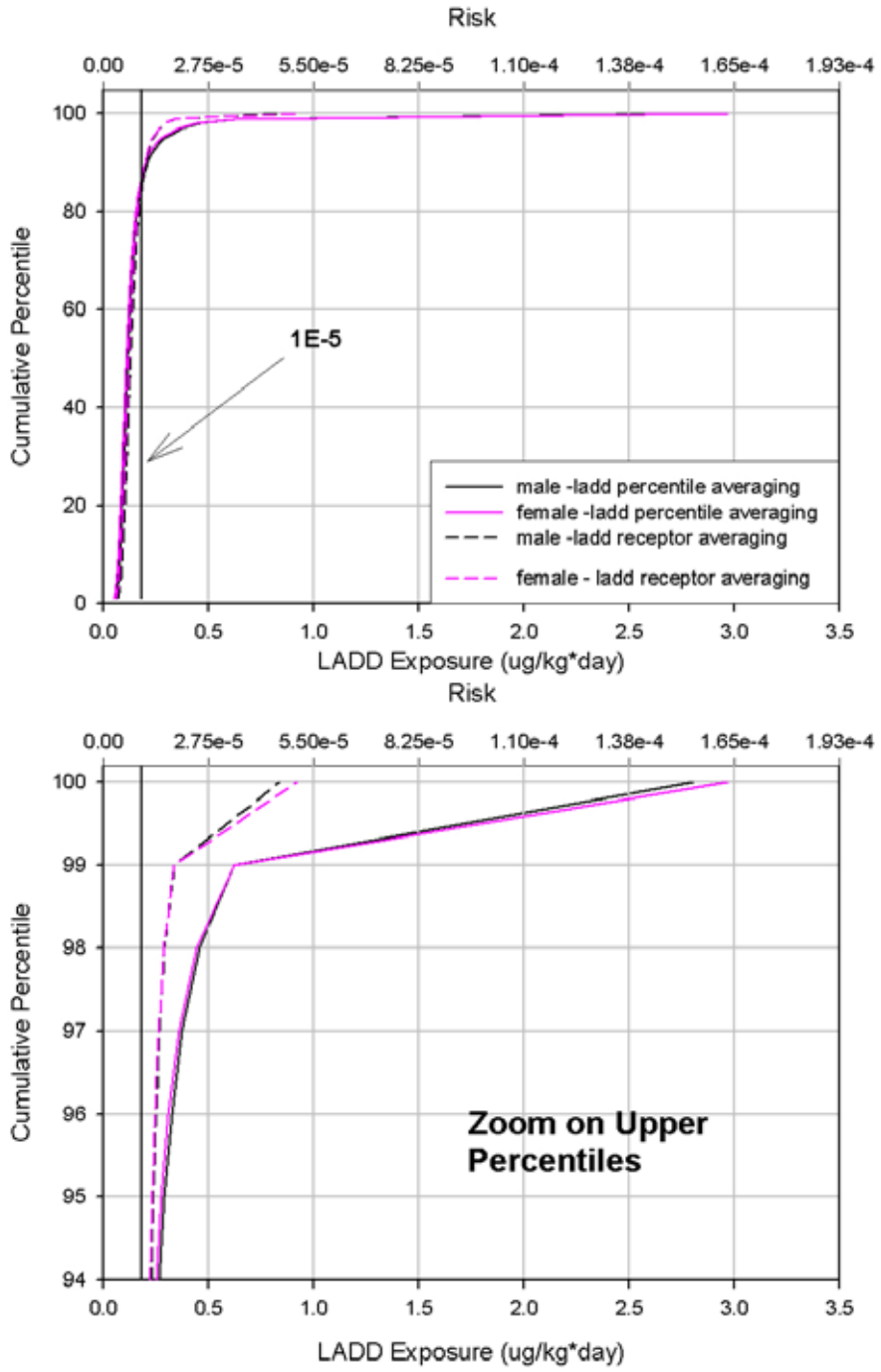


Figure 5. LADD exposure from HEE5CB modeling using receptor vs percentile based averaging techniques as underlying concentration distribution inputs. Concentration distributions from J1245-J1254 set.

The exposure simulation results based on the SOFEA runs J1228-J1237 for the lower-bound estimates (receptor averaging) were 0.25 ug/kg-day and 0.24 ug/kg-day for male and female at the 95th percentile, respectively (Table 10). For the upper-bound estimate the corresponding values were 0.29 ug/kg-day and 0.28 ug/kg-day. These exposure values translate to 1.35E-5, 1.32E-5, 1.6E-5, and 1.5E-5 risk, respectively. In terms of percentages, these values exceed the 1E-5 reference by 35%, 32%, 60%, and 50%, respectively. Thus, exposure for males was equivalent to a range of risk estimated to lie between 35% and 60% higher than the reference of 1E-5. Exposure for females was in a range between 32% and 50% higher than the reference of 1E-5.

It is of interest to ask what percentile corresponds to 1E-5 risk. The exposure which corresponds to that level of risk is 0.1818ug/kg-d (=1E-05/5.5E-05). From the data table for Figure 5, the corresponding percentiles are 85%, 87%, 84%, and 86%, for the male lower-bound, female lower-bound, male upper-bound and female upper-bound, respectively.

**Conclusion**

An interim estimate was obtained for the level of risk corresponding to the 90,250 adjusted pound township cap used in California permit conditions for 1,3-d. The level of risk at the 95th percentile of lifetime exposure was between 1.35E-5 and 1.6E-5 for males and 1.32E-5 and 1.5E-5 for females. These estimates were based on ten one-year runs of SOFEA and used five years of meteorological data from each of Ventura and Merced. The modeling utilized statewide 1,3-d use records from 2001 to 2003 as input for field size, application date and rates and crop information. Due to problems with multi-year runs of SOFEA, single-year runs were utilized to estimate an upper- and lower-bound for the exposure.

The upper-bound was based on averaging the yearly cumulative concentration distributions. The lower-bound was based on receptor averaging of the ten one-year runs, and then forming the cumulative distribution. The upper- and lower-bounds at the 95th percentile were higher than the reference risk level of 1E-5. Based on the cumulative distribution curve of exposure, the 1E-5 reference level corresponded to about the 86th percentile for both male and female upper- and lower-bound distributions.

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# APPENDIX

```
C     Last change:  BRJ   5 Jul 2005    2:00 pm
        PROGRAM TRANSFORM2
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C TRANSFORM2 USES A FILE FOR INPUT OF CHANGES BOTH
C TO AUTOMATE THE PROCESS AND TO PROVIDE A RECORD
C OF HOW THINGS GOT TRANSFORMED
C
C CONVERTS ONE YEAR MET FILES INTO MET FILES WITH
C SAME DATA BUT CHANGESYEAR AND HEADERS AND FILENAMES
C AS NECESSARY IN ORDER TO COMBINE YEARS OF DATA FOR
C AGGREGATION FOR 'STATE' SIMULATION
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        IMPLICIT NONE
C 99999   1989  99999   1989
C 89 1 1 1    259.9       0. 287.3 6  320.0  320.0
C 89 1 1 2     270.   1.4801 287.4 6  320.0  320.0
        CHARACTER*80 LINE
        CHARACTER*40 FIN,FOUT
        CHARACTER*5 OLDUSNAM,NEWUSNAM     !USED IN HEADER
        CHARACTER*4 OLDFULLYEAR,NEWFULLYEAR  !USED IN HEADER
        CHARACTER*2 OLDHALFYEAR,NEWHALFYEAR  !USED IN DATA
        CHARACTER*40 FORM2
        CHARACTER*1 ANS
        INTEGER LEN_TRIM ,COUNT,L,K
 !Let's automate this section
 !format for multiple input files will be as follows:
 !oldfilename.mxt
 !newfilename.mxt
 !old upper/lower air #, newupperair#  (comma separator, NO SPACES, EXACT
FORMATTING A5,1X,A5)
 !old header year, newheader year
 !old 2 digit year, new 2 digit year
        OPEN(UNIT=15,STATUS='OLD',FILE='TRANSFORM2.IN')
        OPEN(UNIT=16,STATUS='UNKNOWN',FILE='TRANSFORM2.LOG')
2001    CONTINUE

         READ(15,110,END=3000)FIN
110      FORMAT(A40)
         READ(15,110)FOUT

         READ(15,135)OLDUSNAM,NEWUSNAM
135      FORMAT(A5,1X,A5)

         READ (15,155)OLDFULLYEAR,NEWFULLYEAR
155      FORMAT(A4,1X,A4)

         READ(15,175)OLDHALFYEAR,NEWHALFYEAR
175      FORMAT(A2,1X,A2)
```

```
!SUMMARIZE CHANGES

         WRITE (16,200)
200      FORMAT(1X,'SUMMARY OF CHANGES ')
         WRITE (16,205)FIN(1:20),FOUT(1:20)
205      FORMAT(1X,'FILENAMES: ',A20,' -> 'X,A20)
         WRITE(16,210)OLDUSNAM,NEWUSNAM
210      FORMAT(1X,'UPP AIR NAM: ',A5,' -> ',A5)
         WRITE(16,220)OLDFULLYEAR,NEWFULLYEAR
220      FORMAT(1X,'FULL YEAR IN HDER: ',A4,' -> ',A4)
         WRITE(16,230)OLDHALFYEAR,NEWHALFYEAR
230      FORMAT(1X,'DATA CHANGE HALF YEAR: ',A2,' -> ',A2)

         OPEN(UNIT=1,STATUS='OLD',FILE=FIN)
         OPEN(UNIT=2,STATUS='UNKNOWN',FILE=FOUT)
         WRITE(6,2010)FIN(1:18),FOUT(1:18)
         WRITE(16,2010)FIN(1:18),FOUT(1:18)
2010     FORMAT(1X,'NOW PROCESSING... ',A18,' TO ',A18)
         COUNT=0
1        CONTINUE
          COUNT=COUNT+1

          IF(MOD(COUNT-1,4000).EQ.0)THEN
            WRITE(6,293)COUNT-1
293         FORMAT(1X,I5,' RECORDS PROCESSED....')
          ENDIF

          READ(1,300,END=1000)LINE
300       FORMAT(A80)

          IF(COUNT.EQ.1)THEN  !THIS IS FIRST LINE, HEADER LINE, TREAT SPECIAL
             L=INDEX(LINE,OLDUSNAM)
             IF (L.GT.0) THEN
                LINE(L:L+4)=NEWUSNAM(1:5)
             ELSE
                WRITE(6,305)
305             FORMAT(1X,'STRING NOT FOUND ')
                STOP
             ENDIF

             L=INDEX(LINE,OLDUSNAM)  !GET SECOND ONE
             IF(L.GT.0)THEN
              LINE(L:L+4)=NEWUSNAM(1:5)
             ELSE
              WRITE(6,305)
              STOP
             ENDIF
```

```
              L=INDEX(LINE,OLDFULLYEAR)  !NOW GET THE OLD YEAR
              IF(L.GT.0)THEN
                LINE(L:L+3)=NEWFULLYEAR(1:4)
              ELSE
                WRITE(6,305)
              ENDIF

              L=INDEX(LINE,OLDFULLYEAR)
              IF(L.GT.0) THEN
                LINE(L:L+3)=NEWFULLYEAR(1:4)
              ELSE
                WRITE(6,305)
              ENDIF

              K=LEN_TRIM(LINE)
              WRITE(FORM2,373)K
373           FORMAT('(A',I2,')')
              WRITE(2,FORM2)LINE(1:K)
c             WRITE(6,FORM2)LINE(1:K)
            ELSE  !END OF TREATING VERY FIRST LINE
              LINE(1:2)=NEWHALFYEAR(1:2) !BEGINNING OF TREATMENT OF DATA LINES
              K=LEN_TRIM(LINE)
              WRITE(FORM2,373)K
              WRITE(2,FORM2)LINE(1:K)
c              WRITE(6,FORM2)LINE(1:K)
           ENDIF
          GOTO1   !GO BACK TO READ NEXT LINE IN DATA FILE

1000    CONTINUE
        WRITE(6,400)COUNT
        WRITE(16,400)COUNT
400     FORMAT(1X,I8,' LINES PROCESSED... ')
        CLOSE(1)
        CLOSE(2)
        GOTO2001 !GO BACK TO LIST OF FILENAMES AND DESIRED CHANGES FOR NEXT
DATA FILE
3000    CONTINUE !END OF READING FILENAMES AND PROCESSING
        CLOSE(15)
        CLOSE(16)
        STOP
        END

C     Last change:  BRJ  17 Jun 2005    3:53 pm
                 PROGRAM MAK3X3v3
CCCC
```

```
C ROTATE AND FILL IN 18X18 MATRIX, ROT90 WAS SEPARATELY DEBUGGED AND TESTED
C (TS2.FOR)...IN TESTING THIS, ADDED BUNCH OF PRINT STATEMENTS FOR DEBUGGING
C ...THE PROBLEM WAS THE TWO ARRAYS: ANN9 AND PER9, I HAD ORIGINALLY SET THEM
C UP AS ANN9(3,3,6,6). HOWEVER, FORGOTTEN THAT THE FASTEST CHANGING INDICES
C BY DEFAULT ARE ON THE LEFT.  THUS THESE 2ARRAYS TOTALLY SCREWED UP WHEN
C I LOADED UP THE 6X6 ARRAYS INTO THEM USING COPEE.  SO CHANGED THESE 2 ARRAYS
C TO BE ANN9(6,6,3,3) AND SEEMS TO WORK FINE. WILL NOW ADD BACK IN THE ROTATE
C FEATURE
C
C VERSION 2, DO SEVERAL TOWNSHIPS AND WRITE OUT INTO ONE FILE
c
c version 1, just do one township
C
C THIS PROGRAM READS IN 11 PAIRS OF SECTION WEIGHTS FROM
C 6 TOWNSHIPS IN MERCED AND 5 TOWNSHIPS IN VENTURA
C EACH PAIR IS FOR ANNUAL AND PERENNIAL CROPS
C THESE PAIRS ARE KEPT TOGETHER BECAUSE THERE MAY BE CORRELATIONS
C BETWEEN THEM
C
C THE PROGRAM RANDOMLY SELECTS 9 PAIRS OF WEIGHTS (WITH REPLACEMENT)
C FROM THE GROUP OF ELEVEN, AND RANDOMLY ROTATES THEM EITHER
C 0,90,180,270 DEGREES (EACH PAIR IS ROTATED THE SAME)
C
C THE RESULTING 3X3 (18X18) MATRIX IS WRITTEN OUT
C INTO TWO COMMA SEPARATED FILES WHICH CAN BE EASILY READ INTO
C EXCEL IN PREPARATION FOR DOING THE TOWNSHIP CAP ANALYSIS
C
C
C THE NUMBERING SCHEME FOR SECTION MATRIX ADDRESSING IS
C   1   2   3   4   5   6   I ACROSS TOP, J DOWN
C 1 6   5   4   3   2   1
C 2 7   8   9  10  11  12
C 3 18  17  16 15  14  13
C 4 19  20  21 22  23  24
C 5 30  29  28 27  26  25
C 6 31  32  33 34  35  36
c
c numbering scheme to print out 3x3 townships
c
c    1   2   3
c  1
C  2
c  3
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        IMPLICIT NONE
        CHARACTER*11 ANAM(11)
        CHARACTER*11 PNAM(11)
        DATA ANAM/"06S10EA.CSV","06S11EA.CSV","06S12EA.CSV",
     1            "07S10EA.CSV","07S11EA.CSV","07S12EA.CSV",
     1            "02N22WA.CSV","02N21WA.CSV","02N20WA.CSV",
     1            "01N22WA.CSV","01N21WA.CSV"/
```

```
        DATA PNAM/"06S10EP.CSV","06S11EP.CSV","06S12EP.CSV",
     1           "07S10EP.CSV","07S11EP.CSV","07S12EP.CSV",
     1           "02N22WP.CSV","02N21WP.CSV","02N20WP.CSV",
     1           "01N22WP.CSV","01N21WP.CSV"/

        REAL ANNW(11,36),PERW(11,36)  !ANNUALS WEIGHTS, PERENNIAL WEIGHTS
MATRIX LISTED BY SECTION NUMBER
        INTEGER I,J,INEW,JNEW,SN2I,SN2J,K,L,M,N,IR,MK,IN
        INTEGER TSI,TSJ
        INTEGER I1,I2,I3
        REAL R1  !RANDOM NUMBER
        REAL DUM1(6,6),DUM2(6,6) !DUMMY TEMPORARY ARRAY
        REAL ANN9(6,6,3,3),PER9(6,6,3,3) !(TSI,TSJ,I,J) TOWNSHIP I (E-W)
C                                                       TOWNSHIP J (N-S)
C                                                       SECTION I (E-W)
C                                                       SECTION J (N-S)
        DO K=1,3
         DO L=1,3
          DO M=1,6
           DO N=1,6
             ANN9(M,N,K,L)=0.
             PER9(M,N,K,L)=0.
           END DO
          END DO
         END DO
        END DO

        DO K=1,11
         DO L=1,36
           ANNW(K,L)=0.
           PERW(K,L)=0.
         END DO
        END DO
        CALL RANDOM_SEED  !THIS INITIALIZES THE RN GENERATOR, DIFFERENT EACH
TIME

        !unit 50 for debugging
        OPEN(UNIT=50,FILE='junk.out',STATUS='unknown')

        CALL LOADER(ANAM,PNAM,ANNW,PERW)  !READS IN WEIGHTS FROM ALL FILES
        DO M=1,100
            CALL RANDOM_NUMBER(R1)  !WARM UP THE RANDOM NUMBER GENERATOR
        END DO

        DO TSJ=1,3
         DO TSI=1,3

          CALL RANDOM_NUMBER(R1)
          IR=INT(11*R1)+1  !AN INTEGER FROM 1 TO 11
```

```
          CALL DUMCLR(DUM1)
          CALL LDTO2D(IR,ANNW,DUM1) !LOAD ANNUAL WEIGHTS INTO DUMMY ARRAY
FIRST
          call dump('A',dum1)
          CALL RANDOM_NUMBER(R1)
          IN=INT(4*R1)  !GENERATES RANDOM INTEGER FROM 0 TO 3 FOR ROTATION
          CALL DUMCLR(DUM2)
C          IN=0 !set this to zero for debugging, no rotation
          CALL ROT90(DUM1,IN,DUM2)  !ROTATE THE DUM1 ARRAY IN TIMES
          call dump('B',dum1)
          call dump('C',dum2)
          CALL COPEE(DUM2,ANN9(1,1,TSI,TSJ))
          WRITE(50,5007)tsj,tsi,IN,ANAM(IR)
5007      FORMAT(1x,'tsj= ',i3,' tsi= ',i3,' ROTATED ',I2,' TIMES',
     1           1X,A11,' :x dump')
          call dump('x',ann9(1,1,TSI,TSJ))
          WRITE(50,5000)tsi,tsj
5000      FORMAT(1x,'tsi= ',i3,', tsj=', i3)

          CALL DUMCLR(DUM1)   !NOW REPEAT THE MANIPULATIONS FOR PERMAMENT CROP
MATRIX
          CALL DUMCLR(DUM2)
          CALL LDTO2D(IR,PERW,DUM1)
          CALL ROT90(DUM1,IN,DUM2)
          CALL COPEE(DUM2,PER9(1,1,TSI,TSJ))
         END DO
        END DO

        !AT THIS POINT, WE HAVE 2 ARRAYS, CONTAINING AL 18X18 NUMBERS
        ! WHAT IS NEEDED IS A CLEVER WAY TO PRINT IT OUT RIGHT

        CALL CHEK1(ANN9)
        CALL CHEK1(PER9)
        OPEN(UNIT=1,STATUS='UNKNOWN',FILE='ANN9.OUT')
        DO TSJ=1,3
         DO J=1,6
           WRITE(1,500)(ANN9(I1,J,1,TSJ),I1=1,6),
     1                 (ANN9(I2,J,2,TSJ),I2=1,6),
     1                 (ANN9(I3,J,3,TSJ),I3=1,6)
500        FORMAT(1X,F6.4,5(',',F6.4),1X,6(',',F6.4),1X,6(',',F6.4))
         END DO
         WRITE(1,501)
501      FORMAT(1X)
        END DO
        CLOSE(1)
        OPEN(UNIT=1,STATUS='UNKNOWN',FILE='PER9.OUT')
        DO TSJ=1,3
         DO J=1,6
           WRITE(1,500)(PER9(I,J,1,TSJ),I=1,6),
     1                 (PER9(I,J,2,TSJ),I=1,6),
```

```
     1                 (PER9(I,J,3,TSJ),I=1,6)
         END DO
         WRITE(1,501)
        END DO
        CLOSE(1)
        WRITE(6,5100)
5100    FORMAT(1x,'enter tsi,tsj ')
5200    READ(5,*,END=5300)tsi,tsj
        call dumps(ann9(1,1,TSI,TSJ))
        GOTO 5200
5300    continue
        STOP

        END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE CHEK1(ARRAY)
        !MAKE SURE THE TOTAL IS 9 FOR THESE ELEMENTS
        IMPLICIT NONE
        REAL ARRAY(6,6,3,3)
        REAL SUM
        INTEGER I,J,K,L
        SUM=0.
        DO I=1,6
         DO J=1,6
          DO K=1,3
           DO L=1,3
            SUM=SUM+ARRAY(I,J,K,L)
           END DO
          END DO
         END DO
        END DO
        WRITE(6,100)SUM
100     FORMAT(1X,'CHEK1: SUM = ',F10.5)
        IF(ABS(SUM-9.).GT.0.2)THEN
         WRITE(6,200)
200      FORMAT(1X,'WARNING, SUM DIFFERS FROM 9 ....')
        ENDIF
        RETURN
        END SUBROUTINE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE COPEE(A,B)
CCCCCCC
C COPIES 6X6 IN A TO 6X6 IN B
        IMPLICIT NONE
        INTEGER I,J
        REAL A(6,6),B(6,6)
        DO J=1,6
         DO I=1,6
          B(I,J)=A(I,J)
         END DO
```

```
        END DO
        RETURN
        END SUBROUTINE
cccccccccccccccccccccccccccccccccccc
c
        subroutine dump(c,dd)
        implicit none
        CHARACTER*1 c
        INTEGER i,j
        REAL dd(6,6)
        WRITE(50,5005)c
5005    FORMAT(1x,'dump:',a1)
        do j=1,6
         WRITE(50,5000)(dd(i,j),i=1,6)
5000     FORMAT(1x,6(f6.4,1x))
        end do
        return
        end subroutine
cccccccccccccccccccccccccccccccccccc
c
        subroutine dumps(dd)
        implicit none
        INTEGER i,j
        REAL dd(6,6)
         do j=1,6
         WRITE(6,5000)(dd(i,j),i=1,6)
5000     FORMAT(1x,6(f6.4,1x))
        end do
        return
        end subroutine
        SUBROUTINE LDTO2D(IR,ANN,DUM)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C LOADS LINEAR ARRAY IN ANN INTO 6X6 ARRAY DUM
C USING SPECIAL FUNCTIONS FOR INDICES TO CONVERT
C THE WEIRD SECTION NUMBERS
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        IMPLICIT NONE
        INTEGER IR  !TELLS WHICH TOWNSHIP WEIGHTS TO USE
        REAL ANN(11,36)  !THIS HOLDS ALL OF THE WEIGHTS FOR USE (EITHER
ANNUAL, OR PERENNIAL)
        REAL DUM(6,6) !WILL LOAD INTO THIS ARRAY
        INTEGER I,J,SN2I,SN2J
        INTEGER N
        DO N=1,36
         WRITE(50,5000)ir,n,sn2i(n),sn2j(n),ann(ir,n)
5000     FORMAT(/1x,'ir,n,sn2i(n),sn2j(n),ann(ir,n) - from ldto2d ',2i3
     1          ,2i3,f10.4)
         DUM(SN2I(N),SN2J(N))=ANN(IR,N)
```

```
        END DO
        RETURN
        END SUBROUTINE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE DUMCLR(DUM)
        IMPLICIT NONE
        REAL DUM(6,6)
        INTEGER I,J
        DO I=1,6
         DO J=1,6
          DUM(I,J)=0.
         END DO
        END DO
        RETURN
        END SUBROUTINE

CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE LOADER(ANAM,PNAM,ANNW,PERW)
        IMPLICIT NONE

        CHARACTER*11 ANAM(11),PNAM(11)
        REAL ANNW(11,36),PERW(11,36)
        REAL WI
        INTEGER K,L,M
        INTEGER TI
        REAL SUM

        DO K=1,11
         SUM=0.
         WRITE(50,5000)k,anam(k)
5000     FORMAT(1x,'from loader k= ',i3,', file= ',a11)
         OPEN(UNIT=1,STATUS='OLD',FILE=ANAM(K))
1         READ(1,*,END=200)TI,WI
          ANNW(K,TI)=WI
          SUM=SUM+WI
          WRITE(50,5600)TI,SUM,WI
5600      FORMAT(1X,'TI= ',I2,' SUM= ',F8.4,' WI= ',F8.4)
          GOTO1
200      CLOSE(1)
         IF(ABS(SUM-1.).GT.0.1)THEN    !MAKE SURE WEIGHTS SUM TO 1.O
                WRITE(50,5200)ANAM(K),SUM
                WRITE(6,5200) ANAM(K),SUM
5200            FORMAT(1X,'WARNING FROM LOADER: SUM NE 1 IN ',A11,2X,
     1                 'SUM= ',F7.4)
                DO M=1,36
                 WRITE(50,5500)M,ANNW(K,M)
                 WRITE(6,5500)M,ANNW(K,M)
5500             FORMAT(1X,I3,2X,F8.4)
                END DO
         ENDIF
```

```
         OPEN(UNIT=1,STATUS='OLD',FILE=PNAM(K))
          SUM=0.
2         READ(1,*,END=300)TI,WI
          PERW(K,TI)=WI
          SUM=SUM+WI
          GOTO2
300      CLOSE(1)
         IF(ABS(SUM-1.).GT.0.1)THEN    !MAKE SURE WEIGHTS SUM TO 1.0
                WRITE(50,5200)PNAM(K),SUM
                WRITE(6,5200) PNAM(K),SUM
         ENDIF
        END DO
        RETURN
        END SUBROUTINE
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        SUBROUTINE ROT90(ARR,N,RARR)
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C ROTATE THE ARRAY ARR BY 90 DEGREES CLOCKWISE
C ARR IS INPUT ARRAY, RARR IS OUTPUT ARRAY
C ARR IS UNCHANGED, N =0,1,2,3 NUMBER OF ROTATIONS
C TO GIVE 0,90,180,270 DEGREES
C OUTPUT ARRAY IN RARR
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        IMPLICIT NONE
        REAL ARR(6,6),RARR(6,6)
        REAL DUM1(6,6),DUM2(6,6)
        INTEGER I,J,N,M,K
        INTEGER NEWI,NEWJ
        DO J=1,6
         DO I=1,6
          DUM1(I,J)=ARR(I,J)  !COPY ARR TO DUM1
         END DO
        END DO
        DO K=1,N  !NUMBER OF ROTATIONS

          DO J=1,6
           DO I=1,6
            DUM2(7-J,I)=DUM1(I,J)
           END DO
          END DO
          DO J=1,6
           DO I=1,6
            DUM1(I,J)=DUM2(I,J)  !COPY DUM2 TO DUM1
           END DO
          END DO

        END DO  !END OF ROTATION LOOP
```

```
          DO J=1,6     !COPY FINAL RESULT TO RARR
           DO I=1,6
            RARR(I,J)=DUM1(I,J)
           END DO
          END DO


        RETURN
        END SUBROUTINE
CCCC
```

```
 j = 54 * i
 'x = Worksheets("mak10-gs").Cells(j, 5)
 'Worksheets("mak10-gs").Cells(i, 7) = x

 Worksheets("mak10-gs").Cells(i, 7) = Worksheets("mak10-gs").Cells(j, 5)
 p = i
 p = p / 216#
 Worksheets("mak10-gs").Cells(i, 8) = p
Next i
End Sub

Sub outar()
Dim x As Single, y As Single, c As Single
Dim i As Integer
'takes the chronic receptor by receptor values, x,y,coords and outputs into
file
'this is from SOFEA run, the chronic worksheet
Open "j1228.out" For Output As #1
For i = 3 To 11666
x = Worksheets("chronic").Cells(i, 1)
y = Worksheets("chronic").Cells(i, 2)
c = Worksheets("chronic").Cells(i, 22)
Print #1, x, y, c
Next i
Close #1

End Sub
'this function takes a date (serial number, though worksheet
'representation may be as a date, eg 3/10/1992
'and converts it to a julian day for that year
'dateserial converts yyyy,mm,dd to a serial number
'then the last day of the previous year serial is
'subtracted
' this procedure avoids worrying about leap years, and
'lets excel worry about leap years

Public Function val2jul(x As Single) As Variant
Dim y As Single, days As Variant
y = 0
y = Year(x) - 1  'get the previous year from this date
days = x - DateSerial(y, 12, 31) 'subtract 12/31/n-1 from the data
val2jul = days  'voila! the days
End Function
```

Section Weights

ANN9.001

```
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.0224,0.0555,0.0000,0.0000 ,0.0000,0.0000,0.0600,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0700,0.0400,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0106 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0200
 0.0000,0.1000,0.0000,0.0400,0.0000,0.0000 ,0.0130,0.0000,0.0911,0.0603,0.0710,0.0209 ,0.0200,0.1200,0.1500,0.0000,0.0000,0.0000
 0.0700,0.1400,0.0600,0.0000,0.0000,0.1200 ,0.0000,0.0649,0.0000,0.0460,0.0371,0.0000 ,0.0200,0.1900,0.0000,0.0500,0.0800,0.0000
 0.0000,0.0300,0.0300,0.0600,0.0000,0.1000 ,0.0128,0.0623,0.1027,0.0442,0.0732,0.0261 ,0.0000,0.0000,0.0000,0.0400,0.0000,0.0300
 0.0500,0.0000,0.0000,0.0500,0.0500,0.0000 ,0.0839,0.0111,0.0255,0.0000,0.0250,0.0403 ,0.1400,0.0000,0.0000,0.0700,0.0000,0.0000

 0.0000,0.0500,0.0500,0.0000,0.0000,0.0500 ,0.0610,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0403,0.0250,0.0000,0.0255,0.0111,0.0839
 0.1000,0.0000,0.0600,0.0300,0.0300,0.0000 ,0.2306,0.0000,0.0350,0.0124,0.0000,0.0390 ,0.0261,0.0732,0.0442,0.1027,0.0623,0.0128
 0.1200,0.0000,0.0000,0.0600,0.1400,0.0700 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0184 ,0.0000,0.0371,0.0460,0.0000,0.0649,0.0000
 0.0000,0.0000,0.0400,0.0000,0.1000,0.0000 ,0.0476,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0209,0.0710,0.0603,0.0911,0.0000,0.0130
 0.0000,0.0000,0.0400,0.0700,0.0000,0.0000 ,0.0742,0.1422,0.0428,0.0000,0.0000,0.0000 ,0.0106,0.0000,0.0000,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0228,0.0350,0.0200,0.1046,0.0404,0.0740 ,0.0000,0.0000,0.0555,0.0224,0.0000,0.0000

 0.0500,0.0000,0.0700,0.0000,0.0000,0.0000 ,0.0571,0.0153,0.0000,0.0167,0.0707,0.0646 ,0.0300,0.1800,0.0300,0.0000,0.0000,0.0000
 0.0000,0.0300,0.1400,0.1000,0.0000,0.0000 ,0.1247,0.0135,0.0117,0.0000,0.0472,0.0721 ,0.0200,0.0000,0.3100,0.0000,0.0300,0.0000
 0.0000,0.0300,0.0600,0.0000,0.0700,0.0000 ,0.0269,0.0643,0.0000,0.0284,0.0209,0.0352 ,0.1100,0.0000,0.0000,0.0000,0.0000,0.0000
 0.0500,0.0600,0.0000,0.0400,0.0400,0.0000 ,0.1127,0.0957,0.0000,0.0000,0.0000,0.0359 ,0.0000,0.1300,0.0000,0.0000,0.0300,0.0000
 0.0500,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0167,0.0000,0.0000,0.0120,0.0000,0.0142 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.1300
 0.0000,0.1000,0.1200,0.0000,0.0000,0.0000 ,0.0324,0.0112,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0000
```

PER9.001

```
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0200 ,0.0000,0.0000,0.1565,0.0000,0.0000,0.0000 ,0.0400,0.0200,0.0100,0.0000,0.0000,0.0100
 0.0200,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0220,0.0000,0.0000,0.0000,0.0899 ,0.0200,0.3100,0.0000,0.0000,0.0000,0.0100
 0.0600,0.0300,0.0600,0.0000,0.0000,0.0000 ,0.0000,0.0863,0.0000,0.0000,0.0369,0.0452 ,0.0300,0.0200,0.0200,0.0200,0.0200,0.0200
 0.0400,0.0200,0.0200,0.0000,0.0000,0.1400 ,0.0000,0.0000,0.0000,0.0000,0.0905,0.1582 ,0.0200,0.0200,0.0300,0.0300,0.0100,0.0700
 0.0300,0.1800,0.0200,0.0000,0.0100,0.0200 ,0.1396,0.0000,0.0298,0.0000,0.0452,0.0589 ,0.0300,0.0600,0.0300,0.0500,0.0000,0.0000
 0.0900,0.1000,0.0200,0.0400,0.0300,0.0400 ,0.0411,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0100,0.0300,0.0300,0.0300,0.0000,0.0000

 0.0400,0.0300,0.0400,0.0200,0.1000,0.0900 ,0.0108,0.0263,0.0284,0.1470,0.1273,0.0144 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0411
 0.0200,0.0100,0.0000,0.0200,0.1800,0.0300 ,0.0000,0.0934,0.1282,0.0435,0.0371,0.0652 ,0.0589,0.0452,0.0000,0.0298,0.0000,0.1396
 0.1400,0.0000,0.0000,0.0200,0.0200,0.0400 ,0.0378,0.0262,0.0715,0.0519,0.0162,0.0000 ,0.1582,0.0905,0.0000,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0600,0.0300,0.0600 ,0.0207,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0452,0.0369,0.0000,0.0000,0.0863,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0200 ,0.0000,0.0254,0.0000,0.0000,0.0000,0.0000 ,0.0899,0.0000,0.0000,0.0000,0.0220,0.0000
 0.0200,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0288,0.0000 ,0.0000,0.0000,0.0000,0.1565,0.0000,0.0000

 0.0900,0.0300,0.0400,0.0600,0.0200,0.0000 ,0.0000,0.0171,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.1200,0.0200,0.0600,0.0800,0.1000
 0.1000,0.1800,0.0200,0.0300,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0367 ,0.0200,0.0900,0.0200,0.0200,0.0400,0.0800
 0.0200,0.0200,0.0200,0.0600,0.0000,0.0000 ,0.1651,0.0000,0.0000,0.0000,0.0000,0.0162 ,0.0100,0.0000,0.0000,0.0300,0.0300,0.0500
 0.0400,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.1188,0.0000,0.0392,0.0843,0.0426,0.0000 ,0.0600,0.0100,0.0000,0.0300,0.0100,0.0500
 0.0300,0.0100,0.0000,0.0000,0.0000,0.0000 ,0.0142,0.0000,0.0524,0.0255,0.0000,0.0000 ,0.0000,0.0000,0.0400,0.0300,0.0000,0.0000
 0.0400,0.0200,0.1400,0.0000,0.0000,0.0200 ,0.0000,0.0509,0.0833,0.1729,0.0808,0.0000 ,0.0000,0.0000,0.0200,0.0000,0.0000,0.0000
```

```
ANN9.005

 0.0000,0.0000,0.0000,0.1100,0.1200,0.2100 ,0.0600,0.0300,0.0000,0.0000,0.0200,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.1300,0.0000
 0.0000,0.0000,0.0000,0.0000,0.1700,0.0000 ,0.0700,0.0800,0.0200,0.1100,0.0000,0.0900 ,0.0000,0.0300,0.0000,0.0300,0.0000,0.0000
 0.0000,0.0800,0.0300,0.0000,0.1900,0.0000 ,0.0400,0.0000,0.0000,0.0400,0.0300,0.0400 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0800 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0300,0.3100,0.0000,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0200,0.0600,0.2200,0.0000,0.0000 ,0.1800,0.0000,0.0000,0.1300,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0600,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0300,0.0200,0.1100,0.0000,0.0000,0.0000

 0.0839,0.0128,0.0000,0.0130,0.0000,0.0000 ,0.0195,0.0785,0.0589,0.0591,0.2050,0.0850 ,0.0000,0.0000,0.0000,0.1200,0.1000,0.0000
 0.0111,0.0623,0.0649,0.0000,0.0000,0.0000 ,0.1303,0.0609,0.0000,0.0543,0.0413,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0500
 0.0255,0.1027,0.0000,0.0911,0.0000,0.0224 ,0.0000,0.0101,0.0000,0.0664,0.0309,0.0000 ,0.0000,0.0400,0.0400,0.0000,0.0600,0.0500
 0.0000,0.0442,0.0460,0.0603,0.0000,0.0555 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0700,0.0000,0.0600,0.0300,0.0000
 0.0250,0.0732,0.0371,0.0710,0.0000,0.0000 ,0.0494,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.1000,0.1400,0.0300,0.0000
 0.0403,0.0261,0.0000,0.0209,0.0106,0.0000 ,0.0183,0.0320,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0700,0.0000,0.0500

 0.0000,0.0106,0.0209,0.0000,0.0261,0.0403 ,0.0403,0.0250,0.0000,0.0255,0.0111,0.0839 ,0.0000,0.0900,0.0400,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0710,0.0371,0.0732,0.0250 ,0.0261,0.0732,0.0442,0.1027,0.0623,0.0128 ,0.0200,0.0000,0.0300,0.0000,0.0000,0.0000
 0.0555,0.0000,0.0603,0.0460,0.0442,0.0000 ,0.0000,0.0371,0.0460,0.0000,0.0649,0.0000 ,0.0000,0.1100,0.0400,0.0000,0.2200,0.0000
 0.0224,0.0000,0.0911,0.0000,0.1027,0.0255 ,0.0209,0.0710,0.0603,0.0911,0.0000,0.0130 ,0.0000,0.0200,0.0000,0.0000,0.0600,0.0000
 0.0000,0.0000,0.0000,0.0649,0.0623,0.0111 ,0.0106,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0300,0.0800,0.0000,0.0000,0.0200,0.0000
 0.0000,0.0000,0.0130,0.0000,0.0128,0.0839 ,0.0000,0.0000,0.0555,0.0224,0.0000,0.0000 ,0.0600,0.0700,0.0400,0.0000,0.0000,0.0600

PER9.005
 0.1200,0.0000,0.0400,0.3100,0.2500,0.2000 ,0.0400,0.0300,0.0700,0.0300,0.0000,0.0000 ,0.1000,0.0800,0.0500,0.0500,0.0000,0.0000
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 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0500,0.0200,0.0100,0.0600,0.0200,0.0400 ,0.0600,0.0200,0.0300,0.0300,0.0300,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0500,0.0300,0.0200,0.0000,0.0300,0.0000 ,0.0200,0.0200,0.0000,0.0000,0.0400,0.0200
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 0.0000,0.0298,0.0000,0.0000,0.0000,0.1565 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0400
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 0.0000,0.0452,0.0905,0.0369,0.0000,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0000,0.0300,0.0200,0.1800,0.1000
 0.0000,0.0589,0.1582,0.0452,0.0899,0.0000 ,0.4643,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.0000,0.0200,0.0600,0.0400,0.0300,0.0900

 0.0000,0.0899,0.0452,0.1582,0.0589,0.0000 ,0.0000,0.0000,0.0000,0.0000,0.0000,0.0411 ,0.0000,0.0000,0.0400,0.0000,0.0000,0.0000
 0.0000,0.0000,0.0369,0.0905,0.0452,0.0000 ,0.0589,0.0452,0.0000,0.0298,0.0000,0.1396 ,0.0000,0.0300,0.0200,0.0300,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0000,0.0000,0.0000 ,0.1582,0.0905,0.0000,0.0000,0.0000,0.0000 ,0.0300,0.2000,0.0600,0.0000,0.0300,0.0200
 0.1565,0.0000,0.0000,0.0000,0.0298,0.0000 ,0.0452,0.0369,0.0000,0.0000,0.0863,0.0000 ,0.0700,0.0400,0.0100,0.0200,0.0500,0.0000
 0.0000,0.0220,0.0863,0.0000,0.0000,0.0000 ,0.0899,0.0000,0.0000,0.0000,0.0220,0.0000 ,0.0300,0.0400,0.0200,0.0300,0.0000,0.0000
 0.0000,0.0000,0.0000,0.0000,0.1396,0.0411 ,0.0000,0.0000,0.0000,0.1565,0.0000,0.0000 ,0.0400,0.0300,0.0500,0.0500,0.0400,0.0200
```
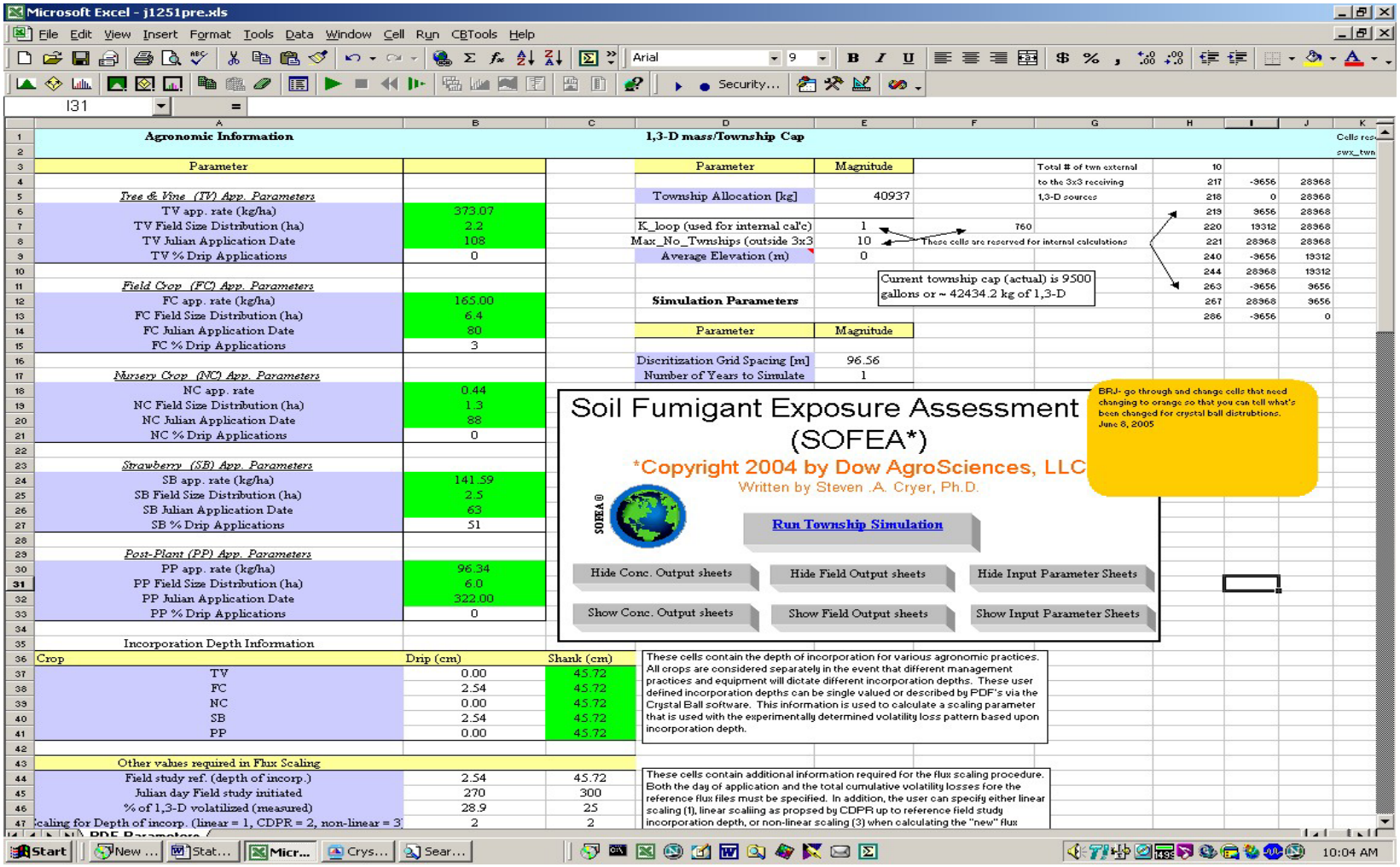

PDF Worksheet



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| Agronomic Information | |
|---|---|
| Parameter | |
| *Tree & Vine (TV) App. Parameters* | |
| TV app. rate (kg/ha) | 373.07 |
| TV Field Size Distribution (ha) | 2.2 |
| TV Julian Application Date | 108 |
| TV % Drip Applications | 0 |
| *Field Crop (FC) App. Parameters* | |
| FC app. rate (kg/ha) | 165.00 |
| FC Field Size Distribution (ha) | 6.4 |
| FC Julian Application Date | 80 |
| FC % Drip Applications | 3 |
| *Nursery Crop (NC) App. Parameters* | |
| NC app. rate | 0.44 |
| NC Field Size Distribution (ha) | 1.3 |
| NC Julian Application Date | 88 |
| NC % Drip Applications | 0 |
| *Strawberry (SB) App. Parameters* | |
| SB app. rate (kg/ha) | 141.59 |
| SB Field Size Distribution (ha) | 2.5 |
| SB Julian Application Date | 63 |
| SB % Drip Applications | 51 |
| *Post-Plant (PP) App. Parameters* | |
| PP app. rate (kg/ha) | 96.34 |
| PP Field Size Distribution (ha) | 6.0 |
| PP Julian Application Date | 322.00 |
| PP % Drip Applications | 0 |

| Incorporation Depth Information | | |
|---|---|---|
| Crop | Drip (cm) | Shank (cm) |
| TV | 0.00 | 45.72 |
| FC | 2.54 | 45.72 |
| NC | 0.00 | 45.72 |
| SB | 2.54 | 45.72 |
| PP | 0.00 | 45.72 |

| Other values required in Flux Scaling | | |
|---|---|---|
| Field study ref. (depth of incorp.) | 2.54 | 45.72 |
| Julian day Field study initiated | 270 | 300 |
| % of 1,3-D volatilized (measured) | 28.9 | 25 |
| Scaling for Depth of incorp. (linear = 1, CDPR = 2, non-linear = 3) | 2 | 2 |

These cells contain the depth of incorporation for various agronomic practices. All crops are considered separately in the event that different management practices and equipment will dictate different incorporation depths. These user defined incorporation depths can be single valued or described by PDF's via the Crystal Ball software. This information is used to calculate a scaling parameter that is used with the experimentally determined volatility loss pattern based upon incorporation depth.

These cells contain additional information required for the flux scaling procedure. Both the day of application and the total cumulative volatility losses fore the reference flux files must be specified. In addition, the user can specify either linear scaling (1), linear scaling as propsed by CDPR up to reference field study incorporation depth, or non-linear scaling (3) when calculating the "new" flux

| 1,3-D mass/Township Cap | |
|---|---|
| Parameter | Magnitude |
| Township Allocation [kg] | 40937 |
| K_loop (used for internal cal'c) | 1 |
| Max_No_Twnships (outside 3x3 | 10 |
| Average Elevation (m) | 0 |

760

These cells are reserved for internal calculations

Current township cap (actual) is 9500 gallons or ~ 42434.2 kg of 1,3-D

| Simulation Parameters | |
|---|---|
| Parameter | Magnitude |
| Discritization Grid Spacing [m] | 96.56 |
| Number of Years to Simulate | 1 |

| Total # of twn external to the 3x3 receiving 1,3-D sources | | | |
|---|---|---|---|
| 10 | | | |
| 217 | -3656 | 28368 | |
| 218 | 0 | 28368 | |
| 219 | 3656 | 28368 | |
| 220 | 19312 | 28368 | |
| 221 | 28368 | 28368 | |
| 240 | -3656 | 19312 | |
| 244 | 28368 | 19312 | |
| 263 | -3656 | 3656 | |
| 267 | 28368 | 3656 | |
| 286 | -3656 | 0 | |

Cells reserved for swx_twn

Soil Fumigant Exposure Assessment (SOFEA*)

*Copyright 2004 by Dow AgroSciences, LLC

Written by Steven .A. Cryer, Ph.D.

SOFEA®

Run Township Simulation

Hide Conc. Output sheets | Hide Field Output sheets | Hide Input Parameter Sheets

Show Conc. Output sheets | Show Field Output sheets | Show Input Parameter Sheets

BRJ- go through and change cells that need changing to orange so that you can tell what's been changed for crystal ball distrubtions. June 8, 2005

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| | A | B | C | D |
|---|---|---|---|---|
| 36 | Crop | Drip (cm) | Shank (cm) | These cells contain the depth of incorporation for various agronomic practices. All crops are considered separately in the event that different management practices and equipment will dictate different incorporation depths. These user defined incorporation depths can be single valued or described by PDF's via the Crystal Ball software. This information is used to calculate a scaling parameter that is used with the experimentally determined volatility loss pattern based upon incorporation depth. |
| 37 | TV | 0.00 | 45.72 | |
| 38 | FC | 2.54 | 45.72 | |
| 39 | NC | 0.00 | 45.72 | |
| 40 | SB | 2.54 | 45.72 | |
| 41 | PP | 0.00 | 45.72 | |
| 42 | | | | |
| 43 | Other values required in Flux Scaling | | | These cells contain additional information required for the flux scaling procedure. Both the day of application and the total cumulative volatility losses fore the reference flux files must be specified. In addition, the user can specify either linear scaling (1), linear scaling as propsed by CDPR up to reference field study incorporation depth, or non-linear scaling (3) when calculating the "new" flux distribution when taking into account the depth of incorporation. Note: For shank and drip applications at a depth of 0.0, it is assumed 100% mass loss will |
| 44 | Field study ref. (depth of incorp.) | 2.54 | 45.72 | |
| 45 | Julian day Field study initiated | 270 | 300 | |
| 46 | % of 1,3-D volatilized (measured) | 28.9 | 25 | |
| 47 | caling for Depth of incorp. (linear = 1, CDPR = 2, non-linear = 3) | 2 | 2 | |
| 48 | Max % 1,3-D lost if applied at surface (Untarped) | 28.9 | 100.0 | |
| 49 | Tarp during experiment? (1 = yes, 0 = no) | 1 | 0 | |
| 50 | Hour of day when application is initiated [1-24 for hour] | 10 | 8 | I switched the start times for drip/shank on this spreadsheet. My recollection is that drip started later at 10. And this matches what's on flux_files worksheet BRJ June 20, 2005 |
| 51 | Tarp Information | % applications using Tarp | | These cells contain information about the percentage of time a tarp is used for either a drip or shank injection application. These percentages are broken out by crop type. If a tarp is never used, then a 0% can be assigned. Note: these percentages can be assigned uncertainty via Crystal Ball and PDF generation for the appropriate cell as the VBA code reads these cells on each iteration. |
| 52 | Crop | Drip | Shank | |
| 53 | TV | 0.0 | 0.00 | |
| 54 | FC | 100.0 | 0.00 | |
| 55 | NC | 0.0 | 0.00 | |
| 56 | SB | 100.0 | 0.00 | |
| 57 | PP | 0.0 | 0.00 | |
| 58 | | | | |
| 59 | Receptor Spacing Information | Magnitude | | These cells contain information concerning the receptor height and receptor grid. A receptor grid is assumed to be equally spaced, with the spacing given by the user. For example, for a single township (9656m x 9656 m), if a user specifies a total of 100 grids per side, then the grid spacing will be 9656/100 or ~ 965.6 m. As the number of grids per side is increased, the spacing between receptors decreases, and the resolution in spatial air concentration increases (of course at the expense of increased CPU time since the number of receptors increases). Cell (80,2) is the flag for receptor placement in the township of interest only (0) or in the entire 3x3 (9 township) domain. |
| 60 | # of grids per township side | 36 | | |
| 61 | Height of receptor (m) | 1.5 | | |
| 62 | Receptors in entire 9 township domain? | 1 | 0 - no, 1 - yes | |
| 63 | | | | |
| 64 | | | | |
| 65 | Weather Year Information | Value | INT(sim year) | These cells contain information about the simulation year and appropriate character strings such that the weather file name can be appropriately generated. This weather file must exist in the weather library or ISCST3 will generate an error message. In addition, ISCST3 requires the ID for both the surface data and upper air meteorological station where the met numbers were measured. These numbers MUST coincide with the same numbers found at the top of each Met file. For example, The user should open up a met file for a CA region, and log the ID's in these files with the cells in this worksheet. When different regions are simulated and different met files are used, both the surface data and upper air Met station ID's must be updated. The "Region of Simulation" is used as a |
| 66 | Simulation Year | 1996 | 1996 | |
| 67 | Weather File Name | cal21996.mxt | | |
| 68 | Concatenation string 1 | cal2 | | |
| 69 | Concatenation string 2 | .mxt | | |
| 70 | Surface Data Met Station ID | 99999 | | |
| 71 | Upper Air Met Station ID | 99999 | | |
| 72 | Region of Simulation | California | | |
| 73 | Path for Weather Library | g:\das\gamma0501\tcp\weather\ | | |
| 74 | | | | |
| 75 | Misc. Parameters | Value | | The pollutant ID is a text string used to comment the ISCST3 input file. The 1st order decay coefficient represents the kinetic rate constants for degradation of the pollutant in air [s-1]. The Terrain flag dictates whether ISCST3 assumes complex terrain (ELEV) or simple FLAT terrain. Thus, the Value for "Terrain" must be either ELEV or FLAT |
| 76 | Pollutant ID (can't have comma's) | Telone | | |
| 77 | 1st order decay coeff [s-1] | 0.000E+00 | | |
| 78 | Anemometer Height [m] | 2.0 | | |
| 79 | Terrain [ELEV or FLAT] | FLAT | | |
| 80 | Round up (1) or Round down (0) grid for field placement | 1 | | |
| 81 | | | | |
| 82 | Buffer Zone Parameters | Value | | These parameters are read in for the CDPR modified version of ISCST3 and |

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I31 =

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 75 | Misc. Parameters | Value | | | | | |
| 76 | Pollutant ID (can't have comma's) | Telone | | | | | |
| 77 | 1st order decay coeff [s-1] | 0.000E+00 | | | | | |
| 78 | Anemometer Height [m] | 2.0 | | | | | |
| 79 | Terrain [ELEV or FLAT] | FLAT | | | | | |
| 80 | Round up (1) or Round down (0) grid for field placement | 1 | | | | | |
| 81 | | | | | | | |
| 82 | Buffer Zone Parameters | Value | | | | | |
| 83 | Length [m] | 33.3 | | | | | |
| 84 | Re-entry Period [days] | 7.0 | | | | | |
| 85 | | | | | | | |
| 86 | Post Processing Information | Value | Avg Per 1 [day] | Avg Per 2 [day] | etc. | | |
| 87 | Number of averaging periods | 0 | 1 | | | | |
| 88 | # data points in percentile summary | 500 | | | | | |
| 89 | | | | | | | |
| 90 | Field Placement Weighting | For 3x3 | For outside 3x3 | | | | |
| 91 | Type of Weighting | 1 | 1 | | | | |
| 92 | GIS_ID | 0 | | | | | |
| 93 | | | | | | | |
| 94 | Crop Type Percentages for each township (For LOOP #1 only) | | | | | | |
| 95 | Township # | TV | FC | NC | SB | PP | Σ (should = 100%) |
| 96 | 1 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 97 | 2 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 98 | 3 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 99 | 4 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 100 | 5 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 101 | 6 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 102 | 7 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 103 | 8 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 104 | 9 | 14.0 | 24.0 | 5.0 | 18.0 | 39.0 | 100.0 |
| 105 | | | | | | | |
| 106 | Random Seed Generation | Value | | | | | |
| 107 | Seed_ID | 1 | | | | | |
| 108 | Seed Number | 12344 | | | | | |
| 109 | | | | | | | |
| 110 | Section Weighted Frequency of Reoccurrence Parameters | Value | | | | | |
| 111 | % of retreated fields the following year | 0.0 | | | | | |
| 112 | Fields Placed outside of 3x3 township domain ? | 1 | | | | | |
| 113 | | | | | | | |
| 114 | | | | | | | |
| 115 | | | | | | | |
| 116 | Temporal Averaging Parameters (Forecasting) | Value | | | | | |
| 117 | Flag if Temporal is assumed | 0 | | | | | |
| 118 | Total number of simulation years per loop | 1 | | | | | |
| 119 | | | | | | | |
| 120 | Misc | Value | | | | | |
| 121 | Boat load memory | 1 | | | | | |

order decay coefficient represents the kinetic rate constants for degradation of the pollutant in air [s-1]. The Terrain flag dictates whether ISCST3 assumes complex terrain (ELEV) or simple FLAT terrain. Thus, the Value for "Terrain" must be either ELEV or FLAT

These parameters are read in for the CDPR modified version of ISCST3 and relate to the Buffer Zone modifications. Currently, there is a 7-day re-entry period following 1,3-D applications in California. Concentrations at any receptor above or within the buffer zone are not used for calculating receptor concentrations, beginning with the application date and ending with the user supplied re-entry days

= 0 (Random) ; = 1 (Section)
= 0 (from Elevation, Population, and LandCover directly) ; = 1 (GIS_data) Which worksheet to get land-cover from

= 0 (Use computer generated Random Seed) ; > 0 (Use user specified Random Seed )
= This is the user specified Random Seed that is used if seeded > 0

= 0 (No), = 1 (Yes). Note, if =1, then the worksheets "Twn_Mass_Wt_Ext and Crop%_Ext must be populated for up to 520 different townships "External" to the central 3x3 township domain.

6/22/05 I used zero percent repeat fields, to test the ability to run two years and test the crop percentrages realization

= 0 (No). If flag_temporal = 0, then the simulation will use the township weightings found in "Twn_Mass_Wt" for Loop #1 and execute the simulation for the total number of years provided in Cell $E$17 (N_yrs).

> 0 (Yes, then the simulation will run for N_yrs*N_loop_tot ) The user will have to define the township cap weightings in worksheet "Twn_Masss_Wt" for each loop up to "N_loop_tot").
The township weightings for each N_LOOP years must be specified in the worksheet

PDF Parameters

Ready

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I31 =

| | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 120 | Misc | Value | > 0 (Yes, then the simulation will run for N_yrs*N_loop_tot ) The user will have to define the township cap weightings in worksheet "Twn_Masss_Wt" for each loop up to "N_loop_tot"). The township weightings for each NLOOP years must be specified in the worksheet "Twn_Mass_Wt", for Loop #1, Loop #2, ... Loop # N_loop_tot. | | | | |
| 121 | Boat_load_memory | 1 | | | | | |
| 122 | CA Scenario for 1,3-D (0) or all other Scenarios (1) | 0 | | | | | |
| 123 | | | | | | | |
| 124 | Buffer setbacks (only used for 24-hr max. concentrations) | Value | | | | | |
| 125 | Call Buffer algorithms [ =0 (No), =1 (Yes) ] | 0 | | | | | |
| 126 | Distance between neighboring receptors along setback [m] | 160.0 | | | | | |
| 127 | Raster grid discritization for single township "I_dis" [i.e., 100x100 | 3000 | Setback 1 (m) | Setback 2 (m) | Setback 3 (m) | etc. | |
| 128 | Number of buffers investigated, followed by length | 1 | 30.48 | 60.96 | 121.92 | 243.84 | 457.20 |
| 129 | | | | | | | |
| 130 | Temporal Flux Scaling Factor Parameters | Value | | | | | |
| 131 | Algorithm (=0 for CDPR, 1 for Sinusodal) | 0 | | | | | |
| 132 | Sinusoidal Parameter "y0" | 27.10 | | | | | |
| 133 | Sinusoidal Parameter "a" | 4.26 | | | | | |
| 134 | Sinusoidal Parameter "b" | 330.52 | | | | | |
| 135 | Sinusoidal Parameter "c" | 4.425 | | | | | |
| 136 | | | | | | | |
| 137 | | | | | | | |
| 138 | | | | | | | |
| 139 | | | | | | | |
| 140 | | | | | | | |
| 141 | | | | | | | |
| 142 | | | 1.0 | | | | |
| 143 | | | | | | | |
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| 163 | | | | | | | |
| 164 | | | | | | | |
| 165 | | | | | | | |
| 166 | | | | | | | |

$$\text{Cumulative \% Volatilized} = y0 + a * \sin\left(\frac{2\pi x}{b} + c\right)$$

where x = Julian day

**** The user must specifiy this many "loop" parameters for the simulation to complete. Unique loop parameters are found in worksheets. Currently, 0< Loop <= 5. Do not delete this cell as an error check routine verifys that it is a valid integer between 1-5. If not, a message box will pop-up to warn the user and the simulation will be stopped.

Forecasts
Twn_Mass_Wt
Twn_Mass_Wt_Ext
Crop%Ext

Boat_load_memory = 0 (No), = 1 (Yes).

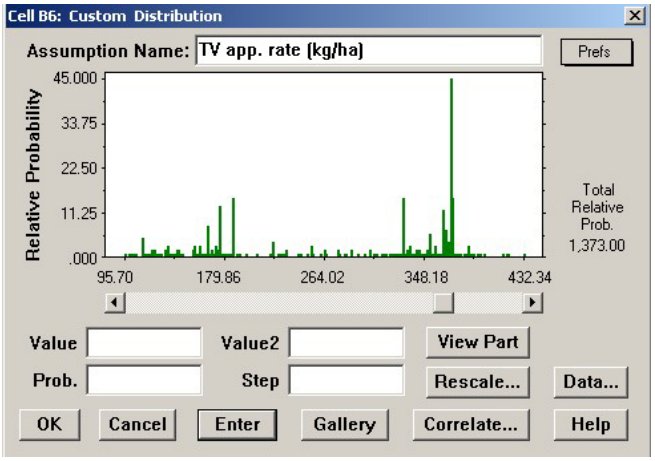
Note, if =1, then the subroutine "Post_Process" is called once each year of simulation has finished executing. (i.e., up to 5 different simulations, 1 for each crop type) The subroutine "Post_Process" ' reads in the 24-hr ISCST3 output files for each crop type, and summarizes the concentration information into a single, 24-hr concentration array for the township (i.e., by summing the air concentration for each field type at each receptor and at the same time). 24-hr exceedence probability data for the township of interest is written to the worksheet "24hr_Summary". In addition, this subroutine also determines the user specified averging period concentrations (Line 87). So if Boat_load_memory = 0, nothing will be written to the output worksheet "24hr_Summary" or "Run_avg_twn". This subroutine has some 3-D arrays that can become huge (and swallow up your system memory" which can end it a failed simulation due to lack of memory resources. Try simulating with Boad_load_memory = 1, and if you receive an error of "Out of memory" or "Insufficient system resources", try resimulating with Boad_load_memory = 0. You will still get the 24hr-max and chronic concentrations.

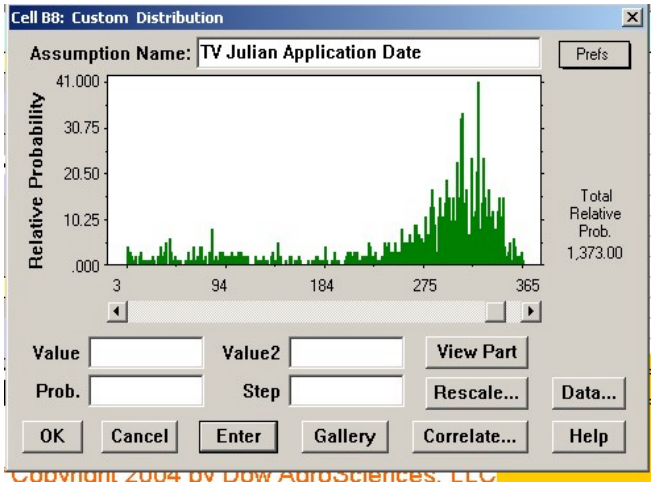
PDF Parameters

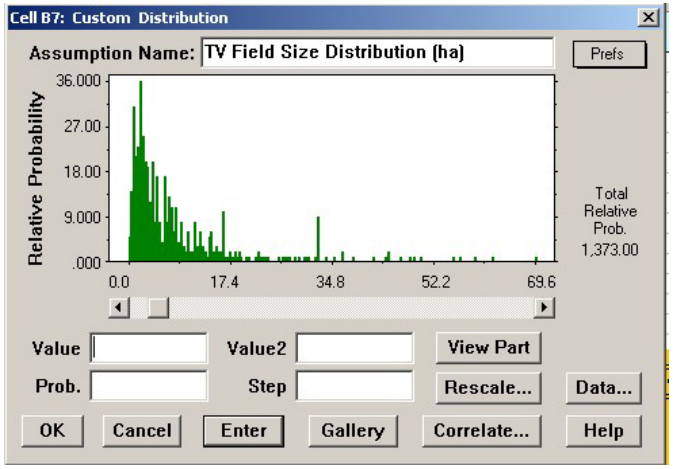
Ready

Frequency distributions used for Monte Carlo sampling of 1,3-d use.

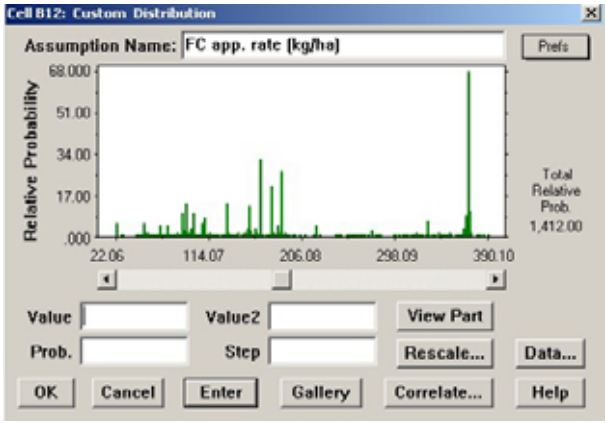
TV



FC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34.00
17.00
.000
22.06
114.07
206.08
298.09
390.10
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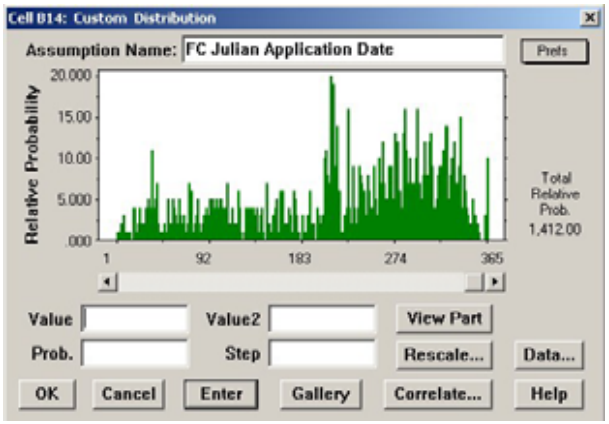
Value2
View Part
Prob.
Step
Rescale...
Data...
OK
Cancel
Enter
Gallery
Correlate...
Help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Assumption Name: FC Julian Application Date
Prefs
Relative Probability
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15.00
10.00
5.000
.000
1
92
183
274
365
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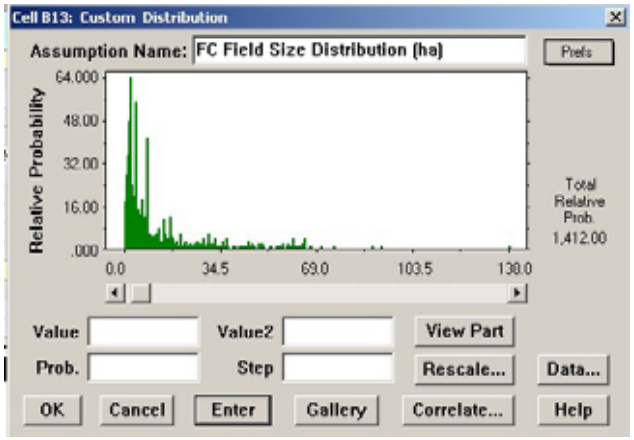
Value2
View Part
Prob.
Step
Rescale...
Data...
OK
Cancel
Enter
Gallery
Correlate...
Help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Assumption Name: FC Field Size Distribution (ha)
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32.00
16.00
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0.0
34.5
69.0
103.5
138.0
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Value2
View Part
Prob.
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Data...
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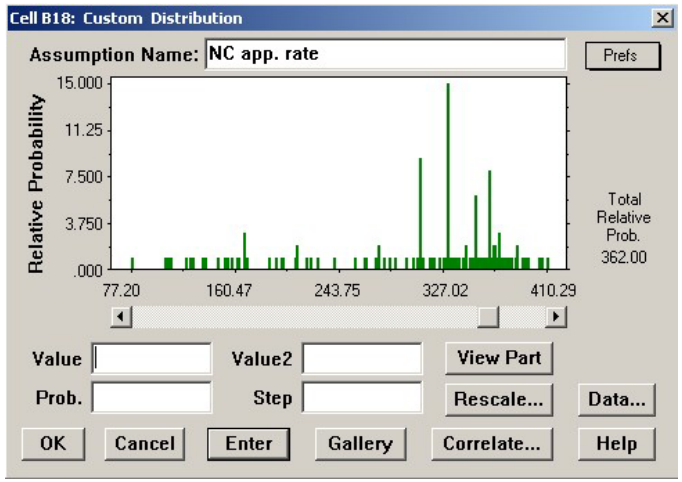
Cancel
Enter
Gallery
Correlate...
Help

NC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Assumption Name: NC app. rate
Prefs
Relative Probability
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11.25
7.500
3.750
.000
77.20
160.47
243.75
327.02
410.29
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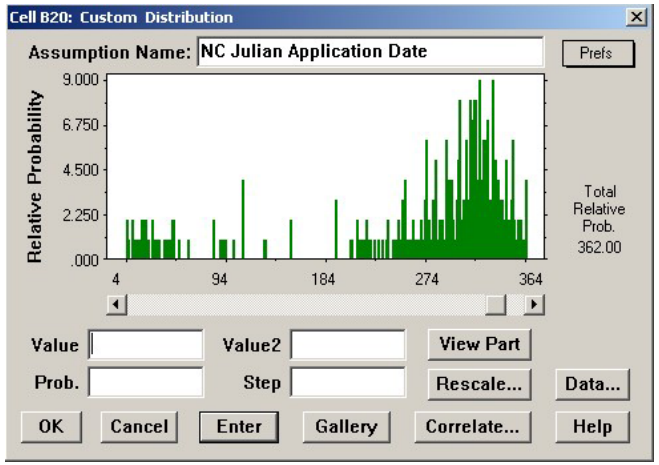
Value
Value2
View Part
Prob.
Step
Rescale...
Data...
OK
Cancel
Enter
Gallery
Correlate...
Help


Cell B20: Custom Distribution
Assumption Name: NC Julian Application Date
Prefs
Relative Probability
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4.500
2.250
.000
4
94
184
274
364
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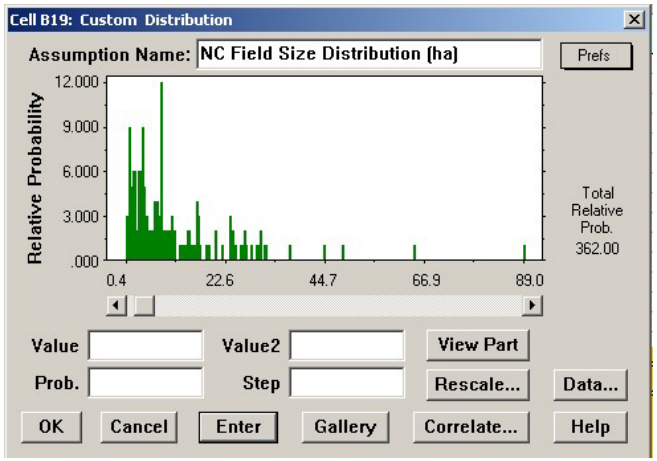
Value2
View Part
Prob.
Step
Rescale...
Data...
OK
Cancel
Enter
Gallery
Correlate...
Help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6.000
3.000
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0.4
22.6
44.7
66.9
89.0
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Prob.
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Data...
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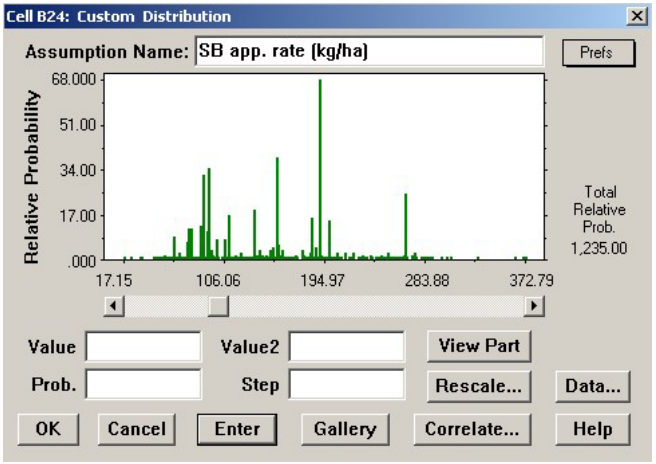
Cancel
Enter
Gallery
Correlate...
Help

SB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Prefs
Relative Probability
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34.00
17.00
.000
17.15
106.06
194.97
283.88
372.79
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Value2
View Part
Prob.
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Rescale...
Data...
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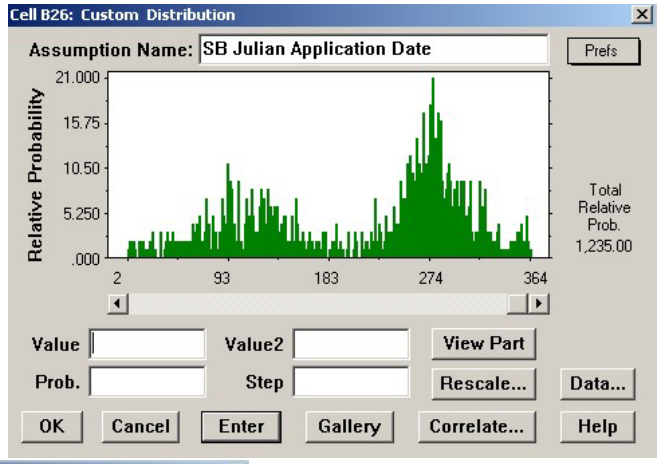
Cancel
Enter
Gallery
Correlate...
Help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Assumption Name: SB Julian Application Date
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10.50
5.250
.000
2
93
183
274
364
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Value2
View Part
Prob.
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Rescale...
Data...
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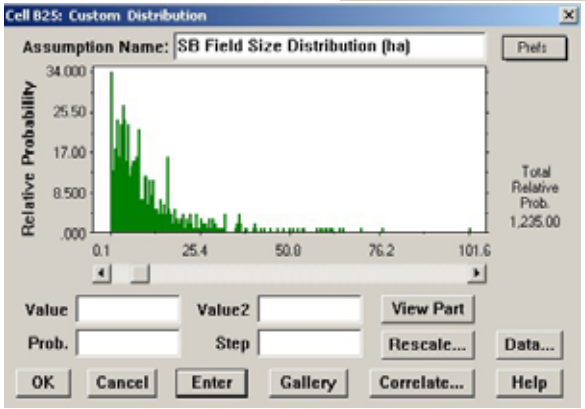
Cancel
Enter
Gallery
Correlate...
Help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17.00
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25.4
50.8
76.2
101.6
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Value2
View Part
Prob.
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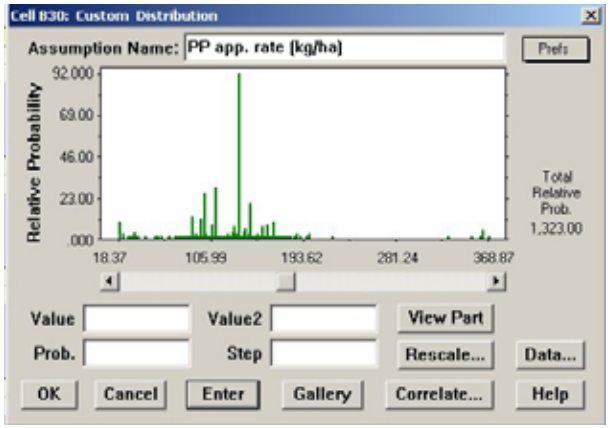
Rescale...
Data...
OK
Cancel
Enter
Gallery
Correlate...
Help

PP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193.62
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Prob.
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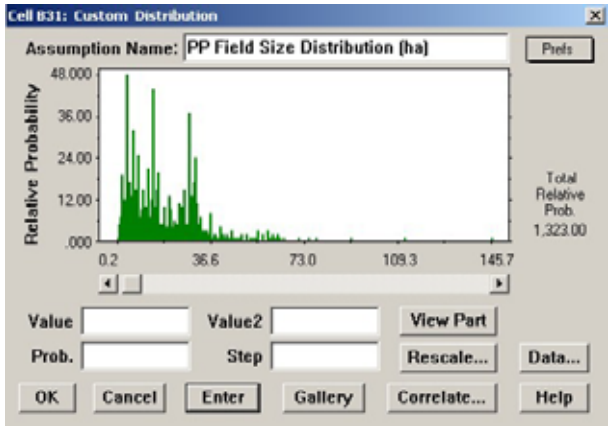
Correlate...
Help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73.0
109.3
145.7
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Value2
View Part
Prob.
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Rescale...
Data...
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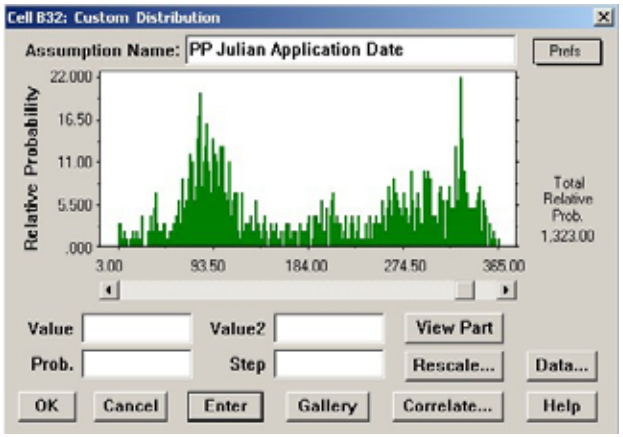
Cancel
Enter
Gallery
Correlate...
Help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.000
3.00
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184.00
274.50
365.00
Total Relative Prob. 1,323.00
Value
Value2
View Part
Prob.
Step
Rescale...
Data...
OK
Cancel
Enter
Gallery
Correlate...
Help

Department of Pesticide Regulation

Mary-Ann Warmerdam
*Director*

Arnold Schwarzenegger
*Governor*

M E M O R A N D U M

TO: Tobi L. Jones, Ph.D., Assistant Director
Division of Registration and Health Evaluation

FROM: Bruce Johnson, Ph.D., Senior Environmental Research Scientist *Original signed by*
Environmental Monitoring Branch
(916) 324-4106

DATE: March 10, 2006

SUBJECT: INTERIM STATEWIDE CAPS RISK ANALYSIS FOR 1,3-DICHLOROPENE WITH SOIL FUMIGANT EXPOSURE ASSESSMENT SYSTEM COMPUTER CODE CORRECTED FOR PROPER BUFFER ZONE CALCULATIONS

## Summary

The Soil Fumigant Exposure Assessment ([SOFEA] V1. dated December 8, 2004) Tool was used to calculate one-year chronic concentration distributions as a basis for an exposure assessment of a 25x25 township area where all townships experienced 1,3-dichloropropene (1,3-d) use at the "township cap" level of 90,250 adjusted use pounds (Johnson and Powell 2005). Subsequent investigation indicated that the SOFEA model did not properly take into account buffer zones (Johnson 2006). The SOFEA computer code was amended to properly calculate buffer zones and the percentile and spatial distributions were recalculated. A high mobility assumption was used. These two distributions represented upper- and lower-bound cumulative concentration distributions and were used as input to the High End Exposure V5 Crystal Ball (HEE5CB) exposure model. The resulting 95th percentile risks for male and female ranged from 99% to 120% of the 1E-5 risk guideline. The impact of properly taking into account the buffer zones reduced risk compared to those estimated in Johnson and Powell (2005). The general conclusion remained, however, that the township cap level, representing a statewide default assumption, cannot be increased in relation to the 1E-5 reference level.

## Background and methods

This memorandum relies on all of the work in Johnson and Powell (2005), which investigated the chronic risk of 1,3-d use when an area of townships were all using 1,3-d at the "township cap" level of 90,250 adjusted use pounds. Subsequent to Johnson and Powell (2005), I investigated the specific part of the code in SOFEA responsible for setting up buffer zones and determined that SOFEA was not properly taking into account buffer zones (Johnson 2006). The buffer zone feature required specification of a 100 foot buffer zone during the first week of application and a 0 foot buffer zone during the second. The latter was to exclude on-field receptors from receiving contributions from the field they were over. By correspondence, persons were not located within buffer zones or on the field during the first week and during the second week persons were not located on the field, but may be within buffer zone distance of the field. See Appendix for explanatory diagram of receptor exclusion.

Code changes that I made included (1) changing references from IRYO to IYRO, (2) adding the argument IYRO to the subroutine Fld_placement argument list, and (3) adding four variables (mon2_beg, mon2_end, day2_beg, day2_end) and appropriate code to construct the receptor exclusion command for the second week. In each case, I tested the code and added comments with the string 'BRJ' to denote my changes. More details may be found in Johnson (2006).

After making the code corrections, I reran ten SOFEA simulations (J1264-J1273) as described in Johnson and Powell (2005), using the section weight configuration ANN9.005/PER9.005 (see Johnson and Powell 2005). Each run was based on a different meteorological year. From these runs I obtained the two ten-year average concentration distributions constituting lower (spatial or receptor averaged) and upper (percentile averaged) concentration distributions (Johnson and Powell 2005). These two concentration distributions were then used as input to HEE5CB with a high mobility assumption, as described in Johnson and Powell (2005). As in Johnson and Powell (2005), 50,000 iterations of sampling were conducted to determine the exposure distribution. Exposure was converted to risk by multiplying by the factor of 5.5E-5 (Reed 2001).

**Results**

Figure 1 displays the resulting concentration distributions compared to the corresponding distributions presented earlier in Johnson and Powell (2005), where the buffer zones were not being used to exclude receptors. When viewed at full scale (top, Figure 1), the four lines are largely coincident until about the 90th percentile. A zoomed view (bottom, Figure 1) shows the general displacement to the left caused by fixing the buffer zone algorithm. At the 98th percentile, the upper bound for the buffer zone corrected distributions (dash-dot) is about the same as the lower bound for the previous calculations without buffer zones (dash-dash). At the 95th percentile the combined width of the two zones was much less than at the 98th percentile and above. The receptor points, which were excluded by buffer zones, were amongst the highest concentrations and mainly affected the high end (95th percentile and above) of these concentration distributions.

Figure 2 shows the exposure limits for male and female based on the buffer-zone corrected concentration distributions. Differences between sexes were minimal compared to the difference between the upper- and lower-bound based distributions. The solid vertical line rising above about 1.8 ug/kg-d corresponds to 1E-5 risk. Ideally, the range at the 95th percentile would encompass this line. However, only the female range marginally included this intersection.

Table 1 presents the 95th percentile statistics for the concentrations, exposure and risk, both for the uncorrected and corrected buffer zone calculations. In Johnson and Powell (2005) the corresponding table is Table 10. Both sets of runs in Table 1 (J 1244-J1253 and J1264-J1273) used section weighting scheme ANN9.005/PER9.005 (see Johnson and Powell 2005). Without the buffer zone exclusions estimated male risk ranged from 32% to 59% higher than 1E-5, the

reference risk level (Gosselin 2001). Without the buffer zone exclusions female risk ranged from 29% to 51% higher. Properly incorporating the buffer zone exclusion resulted in lower concentrations, and hence, lower exposures. With the buffer zone exclusion taken into account, male risk ranged from 2% to 20% higher than 1E-5 and female risk ranged from –1% to +17% of the 1E-5 reference level. Interpolating the reference risk level of 1E-5 using the male and female cumulative risk distributions leads to an estimate for the upper bound (both male and female) at about the 92nd percentile and the lower bound (both male and female) corresponding to about the 95th percentile.

These calculations were intended to evaluate the township cap level of 90,250 adjusted use pounds per township. In this simulation, a 5x5 township area was simulated with each township at the 90,250 pound use level. As a default, statewide capping level on the use of 1,3-d, these results indicate that the township cap cannot be increased with respect to the 1E-5 reference level. The meaning of this calculation applies to the use of 90,250 adjusted pounds as a default level. Special situations are anticipated where, for example, low use in surrounding townships may allow for increased use in certain townships. These special situations will require simulation customized to the specific situation.

**Conclusion**

The SOFEA model was modified to properly take into account the impact of buffer zones. With this modification and with a 5x5 township area simulated at the township cap level of 90,250 adjusted pounds, risk levels at the 95th percentile ranged from –1% to +20% of the 1E-5 reference level. The lower bound risk distribution corresponded to 1E-5 at about the 95th percentile and the upper bound risk distribution corresponded to 1E-5 at about the 92nd percentile. As a statewide default, township caps cannot be increased without increasing the risk beyond 1E-5 at the 95th percentile.

cc: Randy Segawa, Agriculture Program Supervisor IV
Sally Powell, Senior Environmental Research Scientist
Ruby Reed, Ph.D., Staff Toxicologist

**References**

Gosselin, Paul. 2001. Memorandum to Tobi L. Jones, Ph.D., Ron Oshima, and Douglas Y. Okumura on Managing 1,3-d (Telone) chronic risks dated April 9, 2001.

Johnson, Bruce. 2001. Memorandum to Kean S. Goh, Ph.D. on Review of modeling changes conducted by Pacific Environmental Services (Roger Brode) dated April 17, 2001.

Johnson, Bruce and Sally Powell. 2005. Memorandum to Tobi L. Jones, Ph.D. on Interim Statewide Caps Analysis for 1,3-Dichoropropene dated December 28, 2005.

Johnson, Bruce. 2006. Memorandum to Tobi L. Jones. Ph.D. dated February 2, 2006, on buffer zone function in soil fumigant exposure assessment tool.

Reed, Nu-may. 2001. Memorandum to Gary Patterson on Exposure Criteria for 1,3-d dated February 8, 2001.

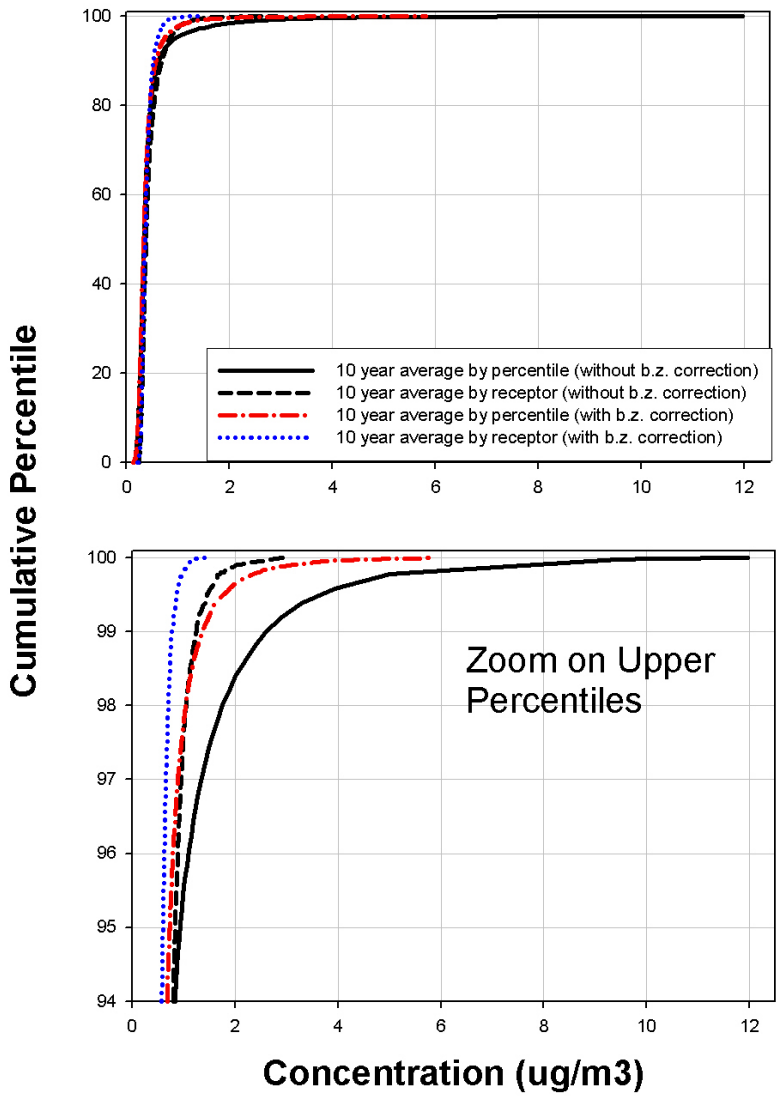



**Figure 1. Comparison of SOFEA 10 year average concentrations by percentile and by receptor for SOFEA version without corrected buffer zone/receptor exclusion (J1245-J1254) and with corrected exclusion (J1264-J1273).**

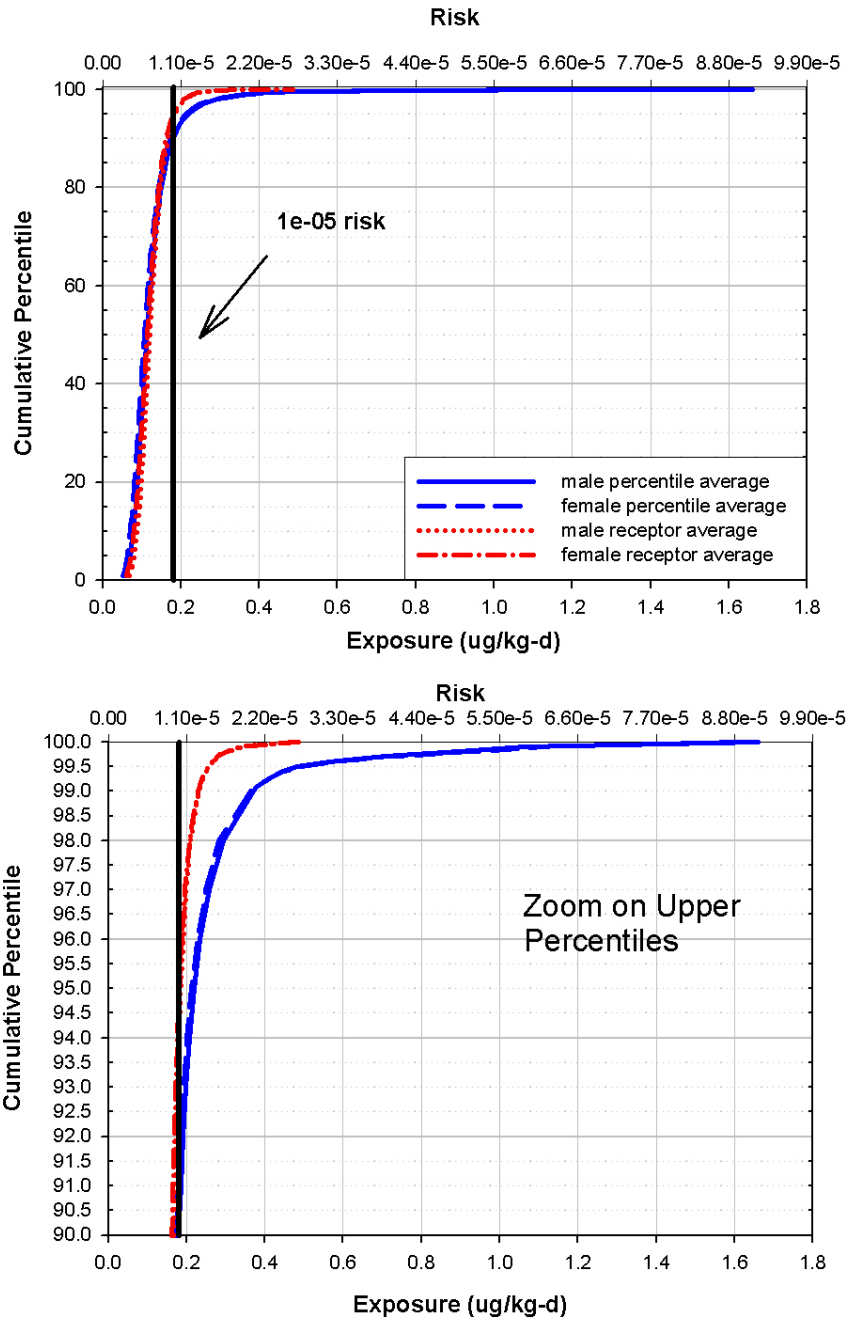
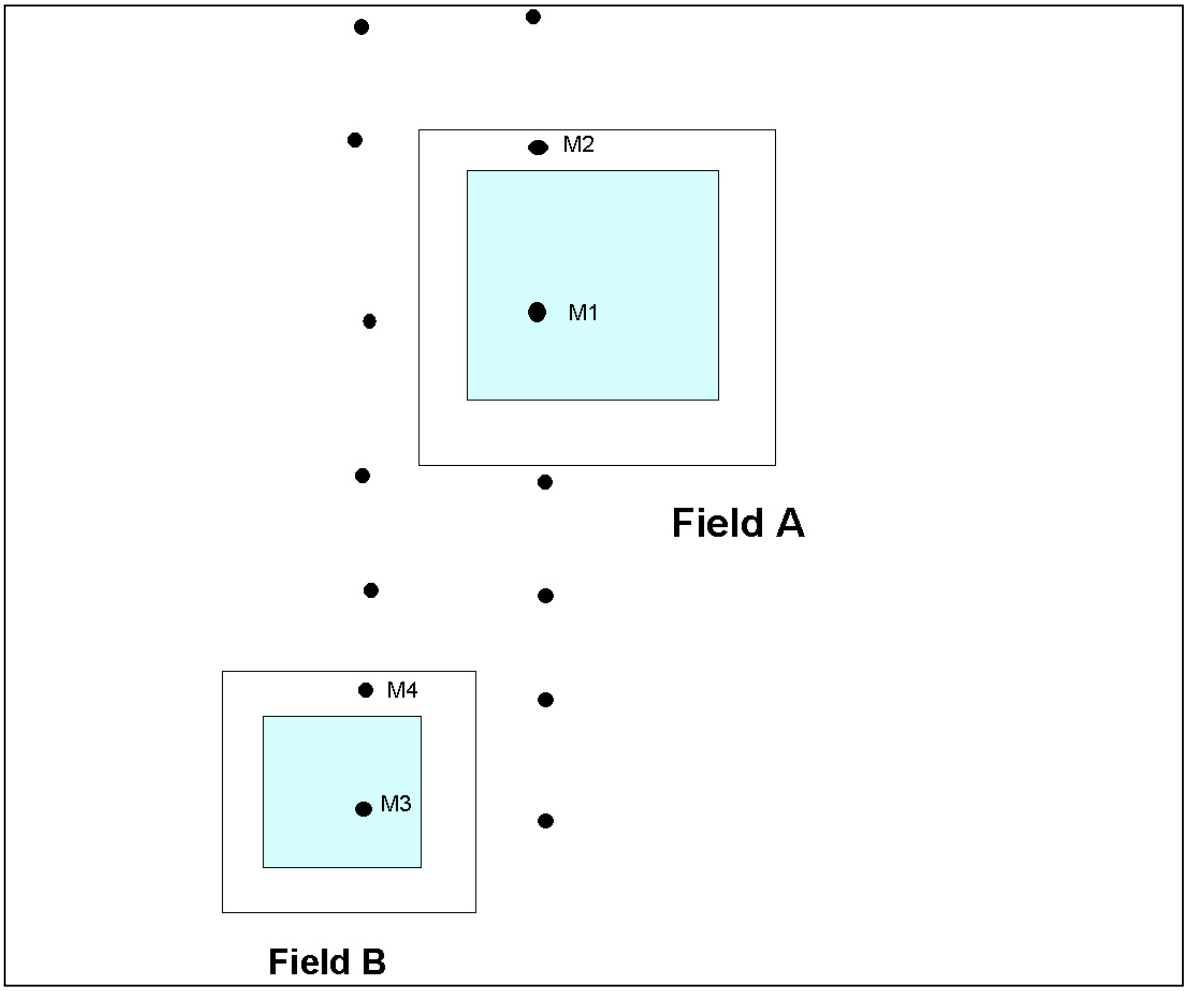



Figure 2. Exposure and corresponding risk distributions based on upper (percentile-averaged) and lower (receptor- or spatial-averaged) concentration distributions from SOFEA with all townships at 90,250 adjusted use pounds.

**Table 1. Summary of 95th percentile statistics for air concentration distributions and exposure distributions. Numbers in parentheses are standard deviations. Series J1244-J1253 was conducted with SOFEA *before* the buffer zone exclusion was fixed. Series J1264- J1273 was conducted *after* the buffer zone exclusion was working properly in SOFEA.**

| | | Buffer zone exclusion not working properly | | | Buffer zone exclusion working properly | |
|---|---|---|---|---|---|---|
| | | J1244-J1253 | | | J1264-J1273 | |
| | | Percentile Average | Spatial Average* | | Percentile Average | Spatial Average* |
| Concentration (ug/m3) | | 0.94 (0.07) | 0.84 (0.69) | | 0.73 (0.09) | 0.60 (0.28) |
| | | | | | | |
| Exposure (ug/kg*day) | Male | 0.29 | 0.24 | | 0.22 | 0.19 |
| | Female | 0.28 | 0.23 | | 0.21 | 0.18 |
| | | | | | | |
| Risk | Male | 1.59E-05 | 1.32E-05 | | 1.20E-05 | 1.02E-05 |
| | Female | 1.51E-05 | 1.29E-05 | | 1.17E-05 | 9.90E-06 |
| | | | | | | |
| *Spatial average is the same as receptor average. | | | | | | |

## Appendix: Explanation of buffer zone exclusion in relation to receptors




In this diagram there are two fields, A and B, which are represented by the shaded smaller squares within the larger square. The surrounding larger square for each field represents the buffer zone. The diagram is not to scale. The buffer zone corners should be rounded, but the drawing software used to prepare this picture does not allow for rounded corners. The black dots represent receptor locations specified in the model. These vertical portions of two columns of receptors represent a small subset of a larger grid of points extending up and down and right and left in the actual simulation. Receptors M1 and M3 each lie on a field. Receptors M2 and M4 lie outside of a field, but within the buffer zone. Each field will flux for two weeks. When field A fluxes, during the first week of flux, all receptors except M2 and M1 will receive contributions from the flux of Field A. Receptors M2 and M1 will be excluded from any contributions from

Field A, but may receive contributions from Field B (if field B happens to be fluxing). During the second week of flux from Field A, receptor M2 will now receive contribution from Field A, but not receptor M1. There is no buffer zone for Field A during week 2, but there is a presumption that nobody will be living on Field A during the second week. Similarly, when Field B fluxes M3 and M4 will be excluded from receiving contributions from Field B, but will receive contributions from any other field which is fluxing at that time. During the second week that Field B fluxes, receptor M4 will now receive contributions from Field B, but not M3. The buffer zone becomes zero during the second week of flux. Fields are generally created not to overlap within a year.

The ISCST3 model was modified to allow for specifying buffer zones in order to create this effect (Johnson 2001). SOFEA utilizes this special feature of ISCST3 when it creates the ISCST3 control files.