
Pacific Northwest National Laboratory

Operated by Battelle for the
U.S. Department of Energy

SPRAYTRAN 1.0 User's Guide: A GIS-Based Atmospheric Spray Droplet Dispersion Modeling System

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Summary

SPRAY TRANsport (SPRAYTRAN) is a comprehensive dispersion modeling system that is used to simulate the *offsite* drift of pesticides from spray applications. SPRAYTRAN functions as a console application within Environmental System Research Institute's ArcMap Geographic Information System (Version 9.x) and integrates the widely-used, U.S. Environmental Protection Agency (EPA)-approved CALifornia PUFF (CALPUFF) dispersion model and model components to simulate longer-range transport and diffusion in variable terrain and spatially/temporally varying meteorological (e.g., wind) fields. Area sources, which are used to define spray blocks in SPRAYTRAN, are initialized using output files generated from a separate aerial-spray-application model called AGDISP (AGricultural DISPersal). The AGDISP model is used for estimating the amount of pesticide deposited to the spray block based on spraying characteristics (e.g., pesticide type, spray nozzles, and aircraft type) and then simulating the *near-field* (less than 300-m) drift from a single pesticide application. The fraction of pesticide remaining airborne from the AGDISP near-field simulation is then used by SPRAYTRAN for simulating longer-range (greater than 300 m) drift and deposition of the pesticide.

SPRAYTRAN was developed for the Department of Agriculture Forest Service and EPA in parallel with development of the DUST TRANsport (DUSTRAN) modeling system for the Department of Defense. DUSTRAN is used to estimate the transport and deposition of particles from vehicular and windblown dust-generating sources at military training and testing ranges. The SPRAYTRAN and DUSTRAN modeling systems are essentially identical, with the primary difference that SPRAYTRAN has features in the "area source" user's interface for loading results from AGDISP, and DUSTRAN has features for specifying numbers and types of vehicles training in an area.

For ease of code maintenance and upgrades, SPRAYTRAN and DUSTRAN are a single program code with identical computer directory structures and information-handling functions. Installing SPRAYTRAN on a computer system also installs DUSTRAN. During the installation process, the user is asked which modeling system to use and then the features corresponding to the selected system are activated. Just as with the code, the respective user's guides are coupled. The DUSTRAN user's guide addresses all the modeling-system functions with the exception of those pertaining to AGDISP interactions. The functions pertaining to AGDISP interactions and spray-drift assessments are detailed in this user's guide. Consequently, the DUSTRAN User's Guide (Allwine et al. 2006) is necessary guidance when using SPRAYTRAN. AGDISP is a separately installed program with its own user's guide (Teske and Curbishley 2002).

References

Allwine KJ, FC Rutz, WJ Shaw, BG Fritz, and BL Hoopes. 2006. *DUSTRAN 1.0 User's Guide: A GIS-Based Atmospheric Dust Dispersion Modeling System*. PNNL-16055, Pacific Northwest National Laboratory, Richland, WA.

Teske ME, and TB Curbishley. 2002. "AGDISP Version 8.07 User Manual." Technical Note No. 02-06. Continuum Dynamics, Inc., Ewing, NJ.

Acronyms

AGDISP	Agricultural Dispersal
AGDRIFT	Agricultural Drift
CALMET	CALifornia METeorological Model
CALPUFF	CALifornia PUFF Model
DoD	U.S. Department of Defense
DUSTRAN	DUST TRANsport
EPA	U.S. Environmental Protection Agency
FS	Forest Service (U.S. Department of Agriculture)
GIS	Geographic Information System
PNNL	Pacific Northwest National Laboratory
SPRAYTRAN	SPRAY TRANsport
USDA-FS	U.S. Department of Agriculture-Forest Service
UTM	Universal Transverse Mercator
VALDRIFT	VALley DRIFT

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Because the foundation of SPRAYTRAN is the DUSTRAN modeling system, we thank the other members of the PNNL DUSTRAN development team for their exceptional efforts. They are Dr. Will Shaw, Mr. Brad Fritz, Ms. Bonnie Hoopes, and Mr. Tim Seiple.

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1.0 Introduction

The drift of airborne pesticides beyond the target site during spray applications is a source of environmental concern because of the potential for human health impacts, downwind contamination and damage to crops and livestock, and endangerment of ecological resources. The amount and ultimate destination of these airborne pesticides is a function of application techniques, environmental conditions, and the physical properties of the spray solution. The sensitivity of drift to numerous factors, including atmospheric conditions, terrain features, and application equipment, makes the use of models necessary for evaluating the potential risks of spray operations and the potential effectiveness of mitigation options.

Several models have been developed to predict the drift and deposition from aerial spray applications. Both empirical and mechanistic models have been used to evaluate near-field spray operations. However, the empirical models do not take into account any physical basis for spray drift and are generally applicable only to situations very similar to those upon which they were developed. Simple, mechanistic models for evaluating near-field spray dynamics have generally fallen into two categories based on the mathematical approach to turbulent mixing—models based on Gaussian dispersion equations and models based on the Lagrangian approach to particle tracking. Gaussian modeling is a classical approach used in evaluating releases from tall stacks and other sources for moderately long-range drift, but provides little resolution in the representation of equipment and near-field dynamics in flow-fields near an aircraft. Resolution and representation of the effects of equipment and near-field dynamics in the flow fields in the vicinity of the spray aircraft have been addressed using Lagrangian particle modeling approaches. Lagrangian models track a cohort of droplets in a given drop size category and overlay a random component to account for atmospheric turbulence. The Lagrangian approach lends itself to detailed modeling of the effects of application equipment on spray dispersal and can be used to evaluate the mitigating effects of alternative equipment uses and near-field buffer zones.

The AGricultural DISPersal (AGDISP) spray model is based on a Lagrangian particle approach to the solution of the spray material equations of motion and includes simplified sub-models for the effects of the aircraft wake as well as the air-generated and ambient turbulence (Teske and Curbishley 2002). AGDISP evaluates many particle-size classes and includes evaporation algorithms for volatile carriers. AGDISP is used by the U.S. Department of Agriculture Forest Service (FS) to evaluate and manage spray applications and forms the basis of a regulatory tool used by the U.S. Environmental Protection Agency (EPA), Office of Pesticide Programs, to evaluate potential impacts from pesticide drift in the pesticide registration process. AGDISP is recommended for use within 300 m of the application area and simulates a single application to a field-scale area. AGDISP does not incorporate the impacts of variable terrain or time-varying, non-uniform meteorology.

Several years ago, Pacific Northwest National Laboratory (PNNL) began a collaborative research effort with the FS and EPA to develop improved atmospheric dispersion models for addressing off-target drift of aerially applied pesticides in mountainous areas. PNNL developed the VALDRIFT (VALLEY DRIFT) model for assessing the drift of pesticides applied in single mountain valleys. VALDRIFT (Allwine et al. 1997) is a phenomenological model accounting for the highly non-stationary and non-homogeneous winds in mountain valleys. The VALDRIFT model coupled with AGDISP was evaluated using pesticide drift data from spray trials conducted in the Mill Creek Canyon of Utah's Wasatch Mountains during the late spring of 1993 (Whaley et al. 1998). The predicted deposition compared within

a factor of three of the observations (70% of the time) at all sampling locations extending to several kilometers down-valley from the spray treatment block. The overall average ratio of predicted-to-observed deposition was 0.9 (Allwine et al. 2002).

A comprehensive assessment of the potential impacts of multiple pesticide applications in a containing watershed or nearby community requires the ability to evaluate multiple applications to multiple fields in an area with variable terrain. The AGDISP-VALDRIFT modeling system was limited in being applicable to only a single mountain valley; thus, it was unable to address the cumulative potential impacts of multiple spraying activities over a region. Consequently, the FS and EPA worked with PNNL to develop the SPRAYTRAN (SPRAY TRANsport) modeling system described in this document. SPRAYTRAN links output from the AGDISP near-field simulation to the EPA-approved CALifornia PUFF (CALPUFF) dispersion modeling system (Scire et al. 2000a). CALPUFF is used to simulate longer-range transport and diffusion in variable terrain with temporally and spatially varying meteorology. SPRAYTRAN is an extension of DUSTTRAN (DUST TRANsport), which is a geographic information system (GIS)-based dispersion modeling system developed for the U.S. Department of Defense (DoD) to simulate the transport and diffusion from dust-generating activities, such as troop maneuvers and convoy movement.

This manual is written as a companion document to the DUSTTRAN User's Guide (Allwine et al. 2006). This user guide addresses SPRAYTRAN-specific operations, such as details on interfacing the AGDISP model results to an area source within the SPRAYTRAN interface. All other aspects of running SPRAYTRAN, such as specifying a model domain or entering meteorology, are detailed in the DUSTTRAN User's Guide and should be referenced therein. Documentation and details pertaining to AGDISP are provided in the AGDISP User's Guide (Teske and Curbishley 2002). A preliminary version of the SPRAYTRAN User's Guide was published by EPA in September 2005 (Allwine et al. 2005). This report supersedes the preliminary guide.

2.0 AGDISP-SPRAYTRAN Linkage

SPRAYTRAN combines detailed source-term and air-dispersion models to simulate the longer range (regional) transport from aerially-applied pesticides. The source-term parameters used to define spray-blocks in SPRAYTRAN are created by using output from a separate, near-field dispersion model called AGDISP (Version 8.08). This section provides an overview of the AGDISP-SPRAYTRAN linkage and the technical basis for the integration.

AGDISP (Bird et al. 2002; Teske and Curbishley 2002; Teske et al. 2002) was designed to optimize agricultural spraying operations and has detailed algorithms for characterizing the release, dispersion, and deposition over and downwind of the application area. AGDISP thus provides detailed results on and nearby the spray block. Spray characteristics, equipment characterization, application information, local meteorology, and surface characteristics are needed to initialize an AGDISP simulation. Large droplets will fall at a rate predominately determined by their size and, as a result, the droplet-size distribution must be characterized by many droplet-size ranges. A single wind speed and direction are adequate to address local scale transport, dispersion, and deposition of spray droplets for short downwind distances (less than 300 m) and spray durations.

SPRAYTRAN is a GIS-based dispersion modeling system that interfaces near-field AGDISP results with the EPA-approved, CALPUFF dispersion model for evaluating the longer range transport, diffusion, and deposition of spray drift. The definition of the characteristics of the source term is a key step in applying SPRAYTRAN; predicting downwind air concentrations and surface deposition requires a good definition of the spray source term. Both SPRAYTRAN and AGDISP require similar input information, but with a change in importance and detail dependent on the different distances being modeled by the respective models. On the spray block, a single wind direction and speed defines the local flow for an AGDISP analysis. To define the potential longer range transport of spray material in SPRAYTRAN, the spatial and temporal patterns of the winds in the full region of interest are needed. In a SPRAYTRAN analysis, the importance of details such as the number of spray passes and their length, width, and height becomes progressively less as the downwind distance increases. Instead, the amount of applied material over the area progressively becomes the dominant source parameter.

The spray-release droplet-size distribution is important in both models. The deposition of the sprayed material on and around the target area is the primary output of AGDISP. Because larger droplets comprise the largest mass fraction of the released material, and these droplets fall rapidly, the near-field deposition rates are normally dominated by the larger droplets. The coupling of the AGDISP computations with SPRAYTRAN extends the analysis to a more detailed air-dispersion analysis of the residual material that has the potential to be carried farther downwind. The linkage of the models requires that appropriate information on the droplet size of the material available for downwind transport be obtained from AGDISP and integrated appropriately into SPRAYTRAN.

The linkage of AGDISP to SPRAYTRAN provides a means of determining the downwind pesticide concentration and deposition fields from SPRAYTRAN based on an “area source” defined using AGDISP results. Some of the SPRAYTRAN area source inputs are automatically specified by selecting in the user interface the use of AGDISP results. This assumes that AGDISP has already been run for the same meteorological and source characteristics inputs to be used in SPRAYTRAN. Before running

SPRAYTRAN, the spray block characteristics (location, shape, and size), spray start time, and spray duration are specified through the user interface. The AGDISP results are then automatically loaded by pointing to the appropriate AGDISP output file through the SPRAYTRAN interface. SPRAYTRAN can then be run, producing concentration and deposition output fields as a function of time for subsequent graphical viewing via the GIS. SPRAYTRAN also allows for the deposition contours resulting from AGDISP to be viewed graphically with the GIS.

AGDISP and SPRAYTRAN operate on much different spatial and temporal scales. SPRAYTRAN computes pesticide concentration and deposition results on a much coarser computation grid than the results computed by AGDISP. Additionally, SPRAYTRAN takes the “driftable fraction” of pesticide remaining in the air from AGDISP after ~300 m (a few minutes) of downwind transport, and assumes it is all released uniformly from the spray-block area throughout the duration of the spraying activity. Currently, SPRAYTRAN operates on 1-hour time steps, thus spreading sub-hour spraying operations over whole hours. The inherent temporal (~ 1-h) and spatial (~500-m) resolution of SPRAYTRAN being considerably coarser than the AGDISP resolutions results in air concentration and deposition contours from the two models likely not matching in the vicinity of the spray block (within 300 to 500 m). However, this potential model resolution mismatch of near-field results does not indicate less reliability in the SPRAYTRAN far-field results, but rather simply reflects the differences in respective model resolutions.

Another potential source for the likely difference between AGDISP and SPRAYTRAN contours in the vicinity of the spray block is if the winds are changing with time over the duration of the spray operations. AGDISP does not treat non-stationary meteorology whereas SPRAYTRAN does. Additionally, the driftable fraction from AGDISP is a function of particle size, whereas SPRAYTRAN currently represents the distribution of particles from AGDISP as simply one particle size (volumetric median diameter, $Dv0.5$). Because the deposition rate of particles is strongly dependent on particle size, the use of $Dv0.5$ in SPRAYTRAN instead of the particle-size distribution could also contribute to potential differences in AGDISP and near-field SPRAYTRAN results. SPRAYTRAN is capable of treating the transport, diffusion, and deposition of a distribution of particle sizes; however, that feature is not currently implemented. Implementation of this feature is planned in the next release of SPRAYTRAN.

Figure 2.1 illustrates the distinct differences in spatial scale and computational domains of the AGDISP and SPRAYTRAN models. The AGDISP and SPRAYTRAN results are complementary and combine to define the fate of sprayed material over and downwind of a spray block. Currently, the AGDISP and SPRAYTRAN results can both be plotted separately in the STRAYTRAN system, but are not merged into a single plot.

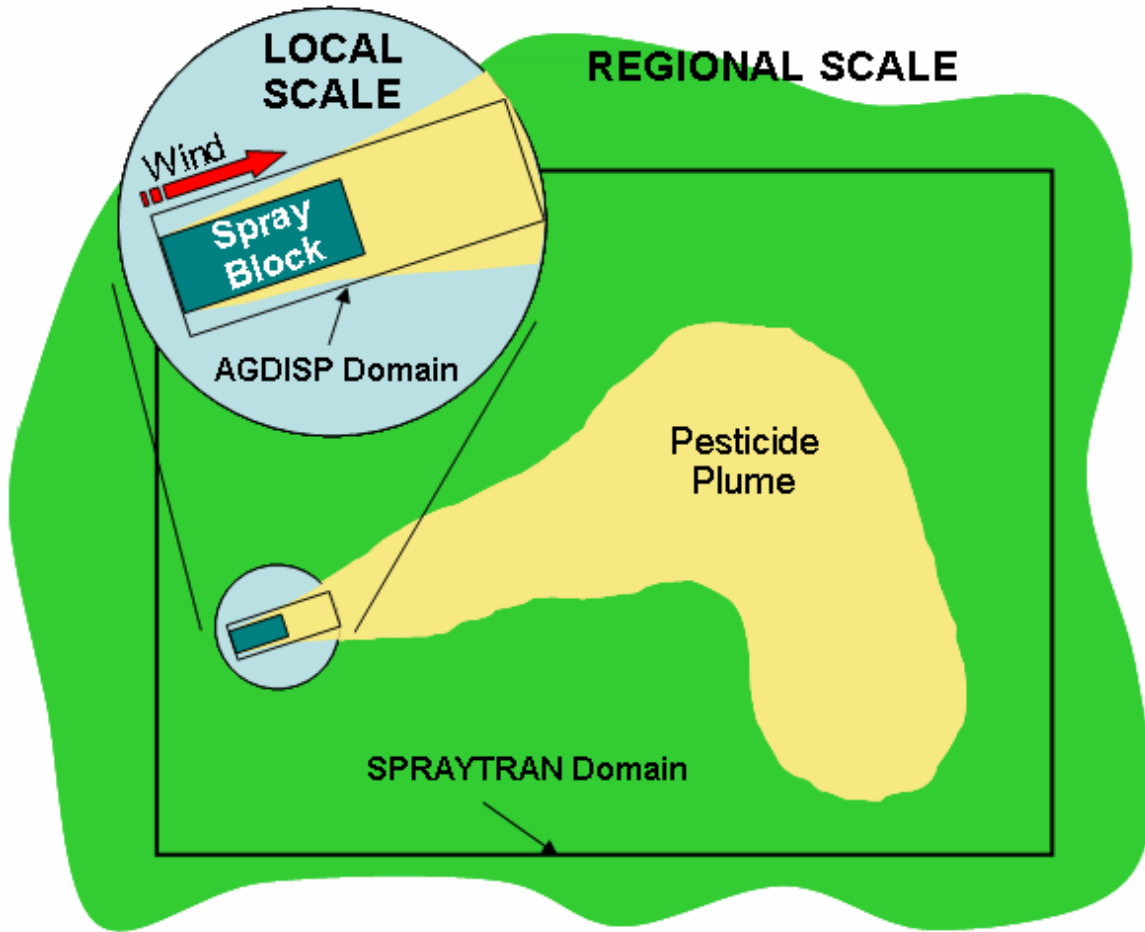


Figure 2.1. Local and Regional Scale Plumes Addressed by AGDISP and SPRAYTRAN

2.1 AGDISP Interface

Once the details of the spraying activities are defined, the AGDISP user starts the analysis by specifying the area and location of the spray block. In the AGDISP main-screen analysis, the spraying direction across the spray block, the effective spray width, and the number of swaths are key input parameters in defining a specific spray application. A spraying direction is selected that is at right angles to, or nearly right angles to, the ambient wind (Figure 2.2). The number of swaths required for a specific application is computed by dividing the length (X_{DW} in Figure 2.2) of the spray block area at right angles to the application direction by the effective swath width.

AGDISP is a 2-dimensional model in height (Z in Figure 2.2) and downwind distance (X in Figure 2.2) that computes the mass of particles deposited and carried downwind from the spraying operations. As described in Section A.2, the inputs and results of the AGDISP main screen analysis are saved to files for the source definition module in the SPRAYTRAN interface. An AGDISP toolbox feature extends the 2-dimensional results (X, Z) to 3-dimensional (X, Y, Z), the crosswind direction, by assuming an infinite line source in the crosswind direction. The length of the flight lines, Y_{CW} , defines

the initial lateral dimension of the plume from the spray block. To have equivalent deposition patterns output to the SPRAYTRAN system, the width (X_{DW}) used in the toolbox must be the same as in the main AGDISP interface, and the area used in the toolbox must be the same as that used in the SPRAYTRAN interface. More detailed information on AGDISP displays, options, and inputs can be found in Teske and Curbishley (2002).

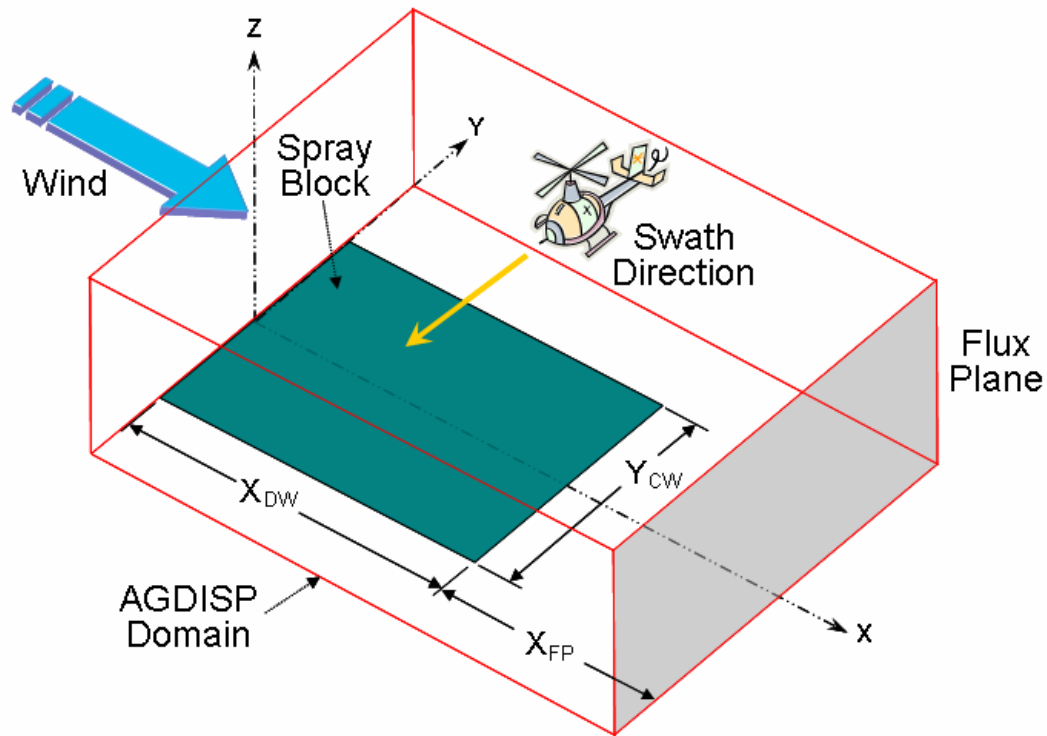


Figure 2.2. Spray Application Direction and Coordinate System Used by AGDISP

2.2 SPRAYTRAN Source-Term Interface

The major components of the SPRAYTRAN system are illustrated in Figure 2.3. The arrows indicate the information and data transfers between the major components (AGDISP, GIS, and CALPUFF dispersion model) that may be required to set-up an analysis in the SPRAYTRAN system. The arrows also indicate the potential for feedback in defining equivalent input parameter values in the SPRAYTRAN and AGDISP interfaces.

To perform an analysis using the AGDISP-SPRAYTRAN linkages, the first piece of required information is the application area. If the user has the dimensions of the spray block, start with the AGDISP interface. If the dimensions are not known, start by defining the application area in the SPRAYTRAN interface.

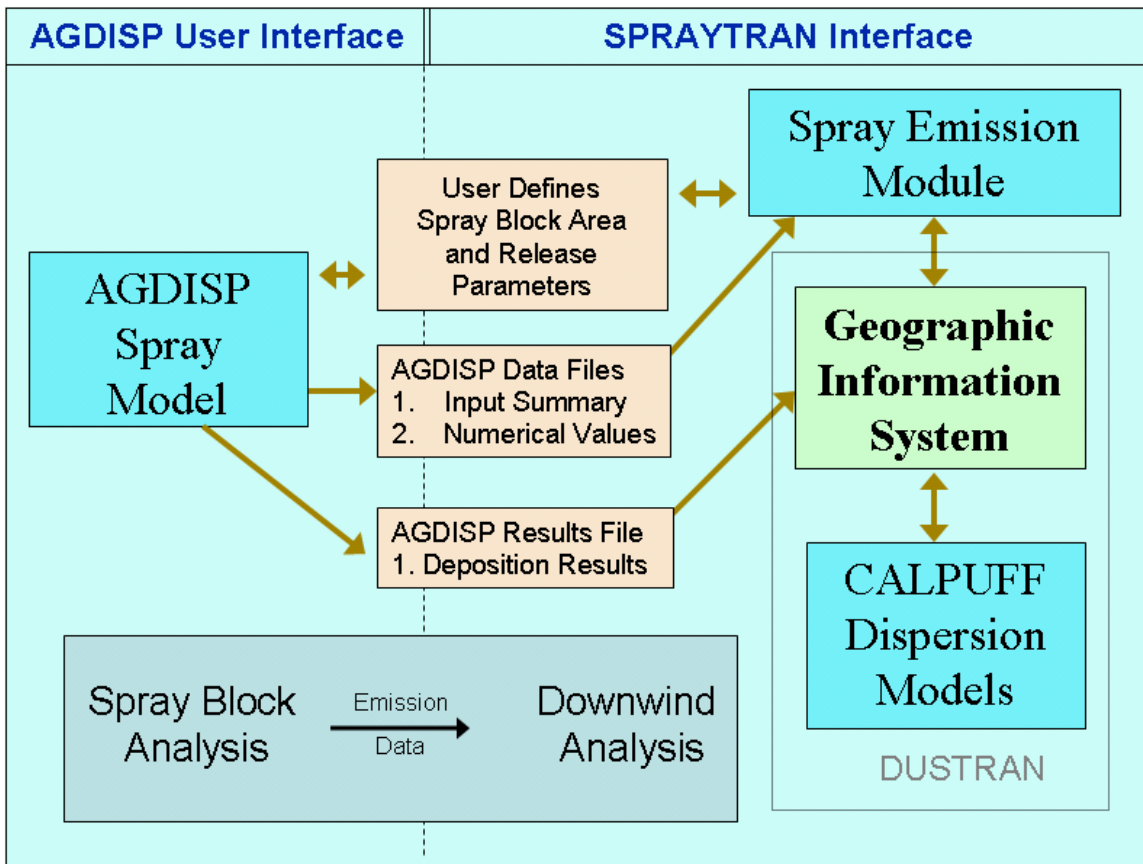


Figure 2.3. Major Components of the SPRAYTRAN Modeling System

If the application area is too large for a single application, or the slopes of the underlying terrain dictate, multiple source inputs from AGDISP will be required. The following discussion applies to each section of area input to the SPRAYTRAN interface as a spray block or a section of a spray block.

As indicated in Figure 2.3, three AGDISP files need to be created from the AGDISP user-interface: 1) Input Data Summary file, 2) Numerical Values files, and 3) Deposition Results file. Table A.1 of Appendix A shows an example of the lengthy Input Data summary file. In Table A.1, AGDISP parameters that are read into SPRAYTRAN and used in its emission rate computations are marked in bold while other parameters potentially important in the linkage (depending on the exact scenario being simulated) are italicized. Table A.1 of Appendix A provides an example Numerical Values file, generated for different values of the AGDISP Flux Plane Distance, an important parameter that will be discussed in more detail in Section 2.2.1. Table A.3 of Appendix A is an example Deposition Results file. As indicated by the units in these appendix tables, the AGDISP metric option must be selected for proper data transfer to SPRAYTRAN.

2.2.1 Interface Distances

There are two key distance parameters that must be defined in AGDISP as part of the source-term linkage. The “Flux Plane Distance,” located in the AGDISP main screen, is a special computation distance defined from the downwind edge of the spray block for which the vertical profile and the drop-size distribution of the spray plume will be available in the AGDISP output files. The “Maximum

Downwind Distance,” as defined under the “Advanced” tab in the AGDISP main screen, represents the distance to which AGDISP will compute dispersion and deposition. The fraction remaining airborne at that distance is used to define the mass of airborne material at that distance (i.e., the active mass aloft). The values imported from AGDISP into SPRAYTRAN for the mean droplet size and active mass aloft must be defined at the same distance downwind of the spray block; for this to occur, the AGDISP parameters “Flux Plane Distance” and “Maximum Downwind Distance” must be set to the same value. Figure 2.2 identifies the flux plane distance (same as maximum downwind distance) for SPRAYTRAN applications as X_{FP} .

Selecting an appropriate distance for these two parameters involves several considerations. The AGDISP constraints (Teske and Curbishley 2002) are that the “Maximum Downwind Distance” should be great enough that effects of the application equipment and evaporation are no longer important processes and that the mean droplet size is no longer decreasing rapidly with distance. The distance should also be consistent with near-source grid spacing being used in SPRAYTRAN. Based on these considerations, a “Flux Plane Distance” and “Maximum Downwind Distance” value of 200 m is recommended.

The values imported from AGDISP into SPRAYTRAN for the mean droplet size and active mass aloft must be defined at the same distance downwind of the spray block. To meet this requirement, AGDISP must be run for the same value of the “Flux Plane Distance” (defined in the main AGDISP screen) and the “Maximum Downwind Distance” (defined in the “Advanced” tab on the main AGDISP screen). The imported “Dv0.5” and “Airborne Drift” are both listed in the “Numerical Values” file created by AGDISP; see Table A.2 for an example.

Data in the third file from AGDISP, “Deposition Results,” are input to the SPRAYTRAN GIS component. Table A.3 of Appendix A lists the constants of the file for the example case (i.e., 200 m column) as well as for other runs with different values for the flux plume distance. The table shows how the size and drift parameters vary across the selected distances. The data in the third file allows the combination of the detailed AGDISP results with the SPRAYTRAN results.

For special cases, the user may wish to study the variation of important parameters with distance. The AGDISP plot of “fraction aloft” from the “Views” menu provides the active airborne fraction as a function of distance. Table A.2 of Appendix A and Figure 2.4 show the variation of the volumetric median diameter that can be obtained from a series of runs with different flux plane distances. This figure is not an AGDISP-generated plot, but is constructed using a separate graphics program to plot results of separate AGDISP runs. Plots such as Figure 2.4 can be used to select an appropriate distance for a spray-drift source term.

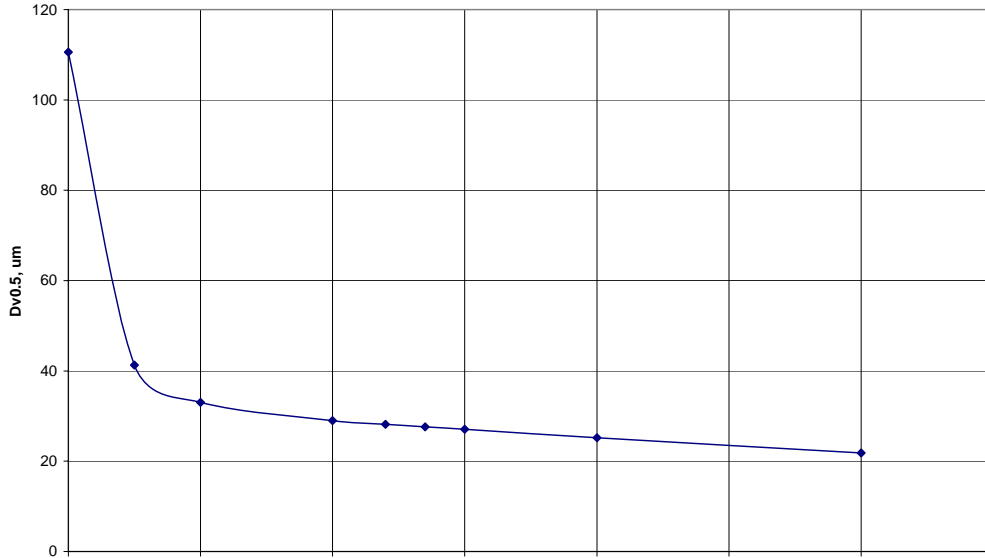


Figure 2.4. AGDISP Dv0.5 Parameter Values from Example Runs in Table A.3

2.2.2 Emission Rate

Equivalent but different emission-rate formulations are used in the AGDISP and SPRAYTRAN models. AGDISP requires as input the volumetric application rate, whereas SPRAYTRAN requires the amount of spray being carried downwind of the application area as an emission rate over a period of time. As a result, the SPRAYTRAN emission rate is some fraction of the AGDISP emission rate.

The total active chemical-agent mass applied in a spray application is computed by Equation 2.1:

$$M_T = s\rho_w V A f_a \quad (2.1)$$

where M_T = Total applied mass (kg)
 s = Specific gravity of spray (dimensionless)
 ρ_w = Density of water (1.0 kg/L)
 V = Spray volume rate (L/ha)
 A = Spray block area (ha)
 f_a = Active chemical agent mass fraction (dimensionless).

A large fraction of the active chemical mass, residing mainly in the larger droplet sizes, by design is deposited on the spray block and on an area immediately downwind. The release duration and computed information from AGDISP on the residual airborne drift provide a means of defining an equivalent SPRAYTRAN emission rate as given in Equation 2.2:

$$\dot{M}_{FP} = \frac{cM_T f_{FP}}{\tau} \quad (2.2)$$

where \dot{M}_{FP} = Equivalent emission rate at a downwind location (g/s)
 c = Units conversion factor (=10)
 f_{FP} = Residual active chemical agent airborne drift (%)
 τ = Duration of release (s).

Combining Equations 2.1 and 2.2, the equation for the equivalent emission rate used in SPRAYTRAN is:

$$\dot{M}_{FP} = \frac{c s \rho_w V A f_a f_{FP}}{\tau} \quad (2.3)$$

This emission rate represents the material applied over the spray block that is still airborne at the specified flux plane distance. The parameters s , V , and f_a are read directly from the AGDISP input summary files (see Table A.1 and Appendix A). The spray block area (A) is calculated within SPRAYTRAN by the user delineation of the spray block. The parameter f_{FP} , the percent of residual airborne active chemical agent at the maximum downwind distance, X_{FP} , in AGDISP, is read from the AGDISP Number Values/Vertical Profile file (Table A.3). The volumetric median diameter of the particles at this distance is also transferred to SPRAYTRAN from the AGDISP Numerical Values/Vertical Profile file (Table A.3) and applied to the computed emission rate. The parameter τ is the release period for the source that the user specifies in SPRAYTRAN.

2.2.3 Spray Block Application Area

Both the AGDISP and the SPRAYTRAN drift dispersion models assume a spray application over some area. Both systems assume a computational spray block area that may require an approximate fit of the actual area.

Because the application area is not passed directly from AGDISP to SPRAYTRAN, an equivalent application area to that used by AGDISP must be specified in the SPRAYTRAN interface. In AGDISP, the area of application is defined as X-Y input parameters. The AGDISP spray block width (X_{DW} in Figure 2.2; number of swaths times the width of a swath, assuming a zero swath displacement) should be consistent with the width of the area defined in the SPRAYTRAN interface.

The length dimension of the area (Y_{CW} in Figure 2.2; corresponding to the length of application swaths) is not as critical in the linkage. The AGDISP toolbox provides the capability of using the initial AGDISP setup to consider spray blocks with different lengths and widths. In the SPRAYTRAN interface, the user can use the initial AGDISP setup to consider spray blocks with different spray application lengths. However, because the data transferred from AGDISP apply to a specific block width, the data should be applied only to blocks with equivalent widths.

AGDISP uses a local coordinate system defined relative to the orientation of the flight lines. AGDISP makes a best-fit of a rectangular box to the area regardless of the orientation of the area. Wind direction in AGDISP is defined in a relative fashion as either being parallel, perpendicular, or somewhere between the sides of the application area. Optimal consistency in source-term linkages within the current SPRAYTRAN system occurs with application swaths that are perpendicular to the wind (i.e., -90 degrees

in AGDISP). The AGDISP source definition parameters that are input into the SPRAYTRAN interface are based on north-south application swaths and an east wind regardless of what application parameters are set in the AGDISP toolbox. The SPRAYTRAN emission module uses those inputs to define a source term for other spray-block configurations in much the same manner as the AGDISP toolbox.

The SPRAYTRAN interface uses a Universal Transverse Mercator (UTM) coordinate system. The application area, as a quadrilateral, is defined by the user selection of three or four points representing the spray block on a map. Although limited to four points, the area does not have to be rectangular, and the area is defined in terms of its actual north-south/east-west orientation.

The deposition pattern imported for viewing in the SPRAYTRAN interface from the AGDISP toolbox must be configured to be equivalent to the application case evaluated in the main AGDISP screen. The deposition patterns generated by AGDISP and SPRAYTRAN can be compared by running special equivalent cases. The spray block “length” dimension needs to be equivalent to the corresponding cross-application path length used in SPRAYTRAN. For an overlapping comparison, the area in SPRAYTRAN must have the same orientation as the AGDISP run. Otherwise, the deposition plots will be plotted as occurring in different directions. The AGDISP “application angle” should be set to zero to correspond with the AGDISP main-menu computations for the “flux plane distance” and “maximum computation distance.” Then in SPRAYTRAN, “Meteorology” should be entered as a single observation with a wind speed and stability that match the AGDISP inputs. The wind direction should be defined such that winds will travel over the spray block in the same way as in the AGDISP runs. Note that wind direction has different meanings in the two tools and cannot simply be imported—in AGDISP, “wind direction” means the angle of air flow relative to the spray block axis; in SPRAYTRAN, “wind direction” is defined as the compass direction from which the air flow is coming (e.g., 180° implies winds are coming from due south). The selection of this wind direction will depend on the actual orientation of the spray block. For an overlapping comparison, the area in the SPRAYTRAN interface must have the same orientation as the AGDISP run. Otherwise, the differently defined “wind direction” in the AGDISP inputs can result in the deposition patterns occurring in different directions.

The local coordinate system in AGDISP and the UTM coordinate system in the SPRAYTRAN interface are combined by assuming that the lower left corner of the deposition pattern from AGDISP is the lower left corner of the spray block in SPRAYTRAN. This plotting procedure matches the assumptions for the source data imported from AGDISP and allows deposition pattern comparisons with plots on the same map. Note that it is necessary to select parameters in the AGDISP toolbox to emulate the assumption of north-south spray paths and east winds. Other cases run with the AGDISP toolbox will not display properly in SPRAYTRAN, and the plotting function of AGDISP should be used to view these cases.

2.2.4 Meteorological Parameters

In addition to the emission-rate parameters, equivalent meteorological parameters will need to be used in the AGDISP and SPRAYTRAN runs. Typical values are run in the AGDISP system and applied to a wider range of values in the SPRAYTRAN analyses. After importing AGDISP data, the user should always check that appropriate values for SPRAYTRAN meteorological parameters are being used.

The SPRAYTRAN source parameters window is populated with values based on AGDISP input. These values appear after the “Load AGDISP” button is selected on a given area source form, and the

associated AGDISP files are identified. The “Effective height above ground” parameter is assigned a value of $\frac{1}{2}$ the release (or boom) height. The “Initial vertical spread” is also assigned a value of $\frac{1}{2}$ the release (or boom) height. These are provided as typical values that may be changed as needed.

The “Air temperature” is assigned the air temperature value from AGDISP. Two other parameters—“Effective rise velocity” and “Effective radius”—are assigned a nominal value of 1 in SPRAYTRAN.

The AGDISP data files are for a single set of wind conditions. That is, the wind speed and direction at the release area are constant over the application time period. Values for these parameters are selected in AGDISP as typical application conditions. The SPRAYTRAN interface allows the user to make “Single Observation” meteorology to verify that both AGDISP and SPRAYTRAN produce similar near-source results.

3.0 SPRAYTRAN Installation Instructions

SPRAYTRAN runs within the ArcMap interface; therefore, ArcMap must be installed before installing SPRAYTRAN. Also note that the installation of this software requires that the user has Administrative privileges on the machine in which it is being installed, so be sure privileges are properly set before proceeding.

SPRAYTRAN runs within the PC environment and has the following system and software requirements:

- ArcView 9.x
- Windows 2000 or XP operating system
- AGDISP must be previously installed. Please see the AGDISP User Manual for installation instructions.

The following sections provide detailed instructions on:

- Installing SPRAYTRAN and setting up access to SPRAYTRAN from within ArcMap
- Installing a sample site.

3.1 Installing SPRAYTRAN

The following steps provide guidance for installing SPRAYTRAN:

1. Before installing SPRAYTRAN, be sure all other applications are closed, including ArcMap.
2. Install the SPRAYTRAN model by double-clicking on the “DUSTRAN.exe” executable file found on the installation CD. Follow the step-by-step installation instructions that are presented by the “InstallShield Wizard.” (*Note:* Even though the executable name is called DUSTRAN, SPRAYTRAN will be installed. The mode of operation is selected near the end of the installation).
3. Towards the end of the installation, the user will be prompted to select the mode of operation. Select “SPRAYTRAN” from the list of available modes (Figure 3.1):

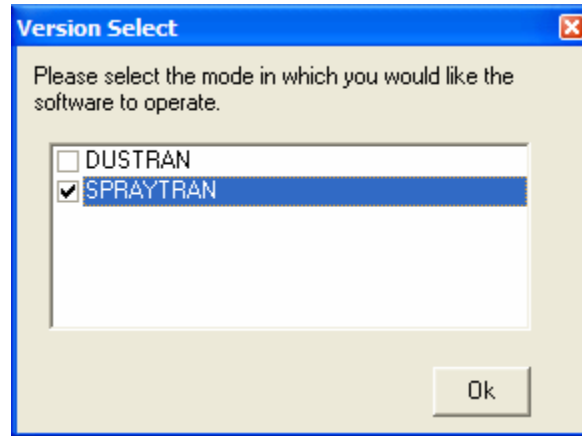


Figure 3.1. Model Selection Window

- Once the installation is complete, SPRAYTRAN can be accessed through a button on the ArcMap toolbar. To add SPRAYTRAN to the ArcMap toolbar, launch ArcMap and click on the “Tools” menu and select “Customize” (Figure 3.2):

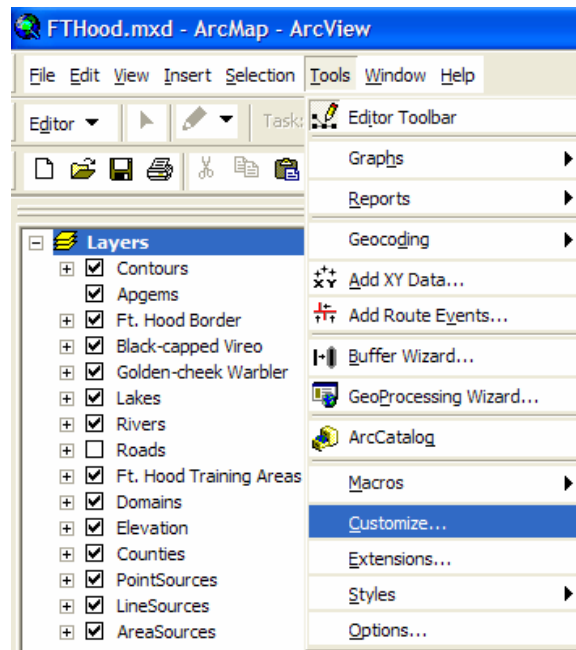


Figure 3.2. ArcMap Tools Menu for Adding SPRAYTRAN to ArcMap

- The “Customize” toolbar dialog window will appear. Click on the “Add from file...” button (Figure 3.3):

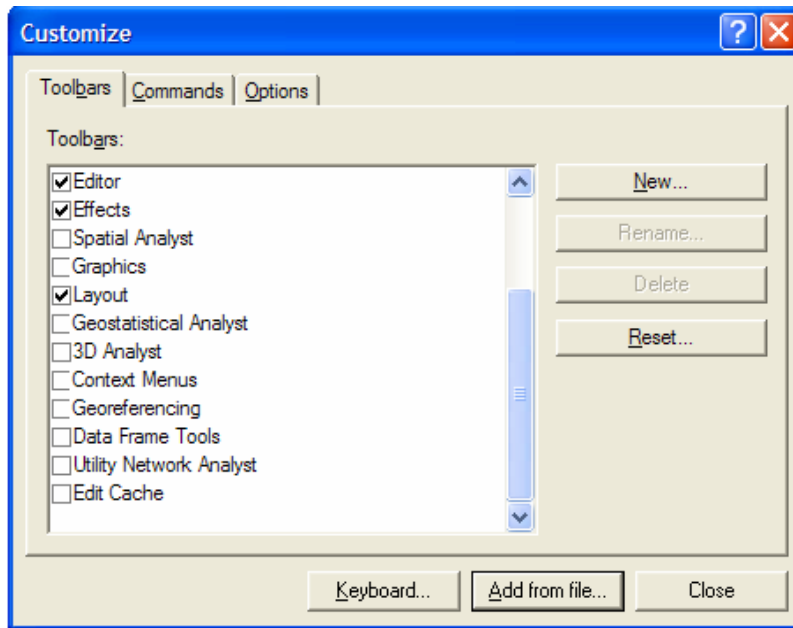


Figure 3.3. ArcMap Customize Menu for Adding SPRAYTRAN to ArcMap

6. Browse to the root SPRAYTRAN directory and select the “DUSTRAN.dll” file and then click “Open” (Figure 3.4):

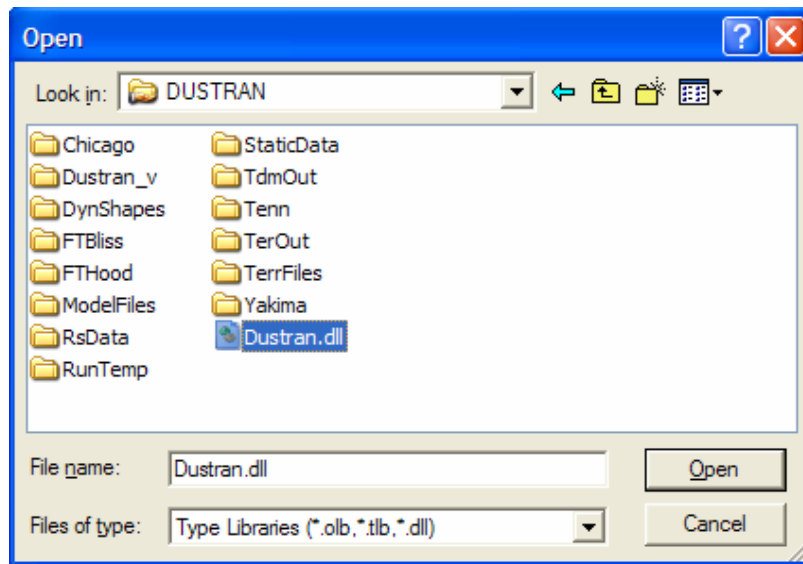


Figure 3.4. Selecting the Dustran.dll file for Adding SPRAYTRAN to ArcMap

7. A window displaying the objects to be added will be displayed. Close this window by selecting the “OK” button.
8. In the “Customize” window, check “DUSTRAN” from the list and click the “Close” button (Figure 3.5).

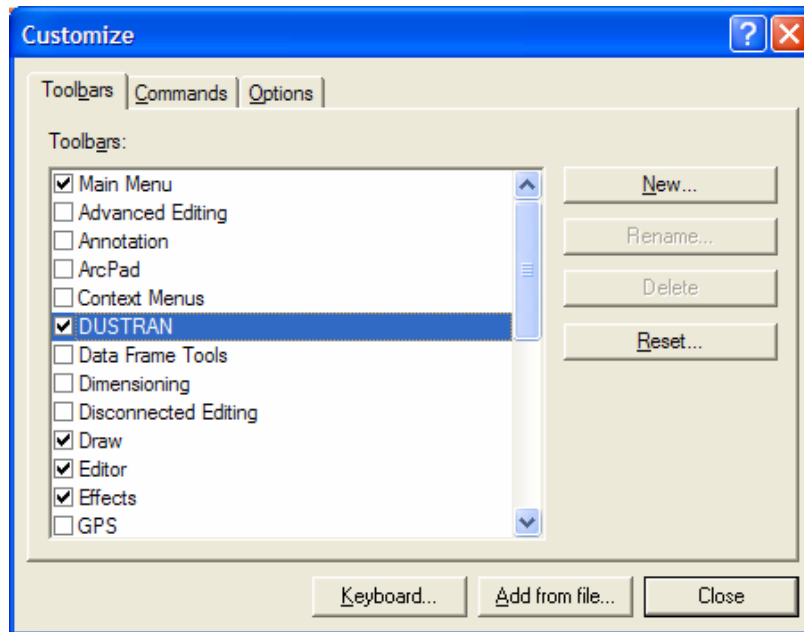


Figure 3.5. Select DUSTRAN for Adding SPRAYTRAN to ArcMap

A button called “SPRAYTRAN,” which is used to launch the SPRAYTRAN model, will appear within the ArcMap interface. (*Note: Newly registered tools are often displayed using an image, or icon, by default. Because the SPRAYTRAN toolbar does not have an associated icon, it is not uncommon for the new toolbar to appear empty. To correct this setting, right-click on the empty toolbar while the Customize dialog is still open. A context [pop-up] menu will appear with several display options. Select the “text-only” option and type the word “SPRAYTRAN” into the text box on the context menu.*)

9. To allow the button to be dockable within the ArcMap toolbar, close the “Customize” window and shut down the ArcMap application.
10. Using Window’s “Explore” or “My Computer,” browse to the directory path, `c:\arcgis\arcexe90\bin`, and start the “categories” executable by double-clicking on the “categories” icon (*Note: SPRAYTRAN requires Version 9.x of ArcGIS.*)
11. Once the “Component Category Manager” window is displayed, scroll down the list and select the “ESRI Mx Dockable Windows” option (Figure 3.6):

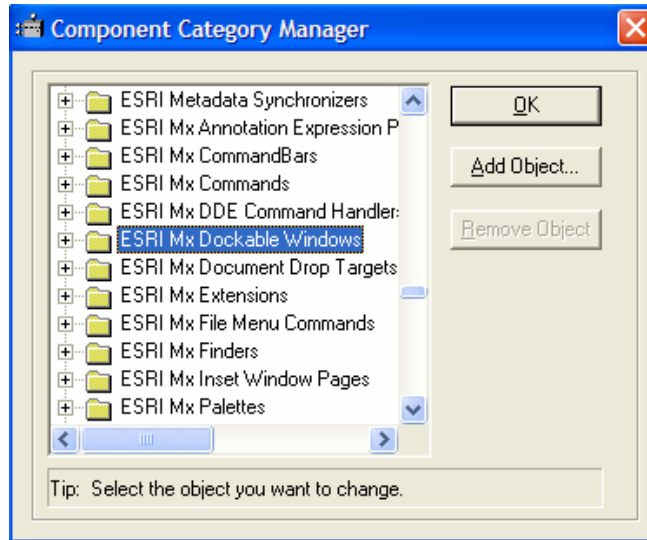


Figure 3.6. Component Category Manager Window for Adding SPRAYTRAN to ArcMap

12. Click on the “Add Object” button, and a file selection window will be displayed.
13. Using the file selection window, navigate to the SPRAYTRAN root directory and select the “DUSTRAN.dll.”
14. Once the “Add Objects” window is displayed, select the “Uncheck All” button and check the “DockWin” option from the list of objects (Figure 3.7):

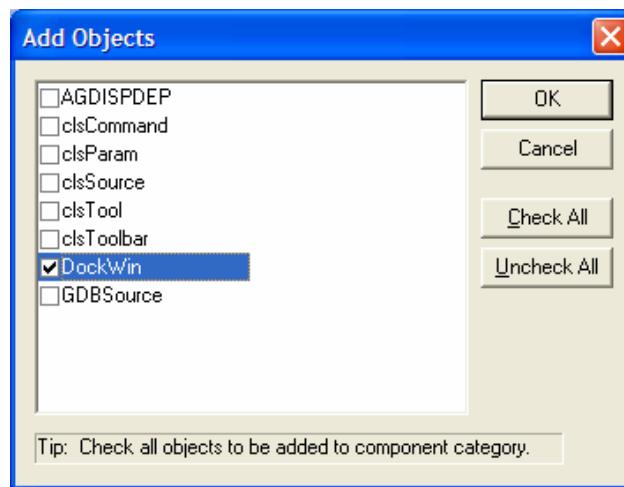


Figure 3.7. The Add Objects Window for Adding SPRAYTRAN to ArcMap

15. Click “OK” and then click “OK” on the “Component Manager Window” to close the program.
16. Launch ArcMap. Drag the SPRAYTRAN button to the ArcMap toolbar and click on the button to begin the application.

3.2 Installing the Example Site

This section steps through the process of installing a sample site from the installation CD. The site, called Tennessee, is included with all SPRAYTRAN installations and is referenced and used in the tutorial (Section 5.0). The user can add site-specific sites at any time with the “Add Site” wizard (see Section 6.0 of the DUSTRAN User’s Guide for adding a new site).

1. Before installing the site, be sure all other applications are closed, including ArcMap.
2. Example sites are available on the installation CD. These sites contain GIS data layers, terrain data, and land-use/land-cover information for making SPRAYTRAN simulations. To install the Tennessee site, double-click on the executable file called “Tennessee.exe.” Follow the step-by-step installation instructions that are presented by the “InstallShield Wizard.”
3. After installing the site, launch ArcMap. Within the SPRAYTRAN interface, click the “Select Site...” button and select the site from the list. To open the Tennessee site, select “Tennessee” from the list. The site will open in SPRAYTRAN and is available for performing a simulation.

4.0 SPRAYTRAN User's Guide

SPRAYTRAN is an extension of the DUSTRAN modeling system; therefore, very few differences exist between the user interfaces. The primary difference, which is documented in this section, is the procedure used for linking the AGDISP model output to SPRAYTRAN to create area source-emission rates. The user should reference Section 4.0 of the DUSTRAN User's Guide for documentation pertaining to all other aspects of the user interface and for guidance in creating a model simulation. In addition, the user may wish to review Sections 5.0 and 6.0 of the DUSTRAN User's Guide to become familiar with additional utilities (e.g., MetArchiver) and capabilities (e.g., Adding a New Site) that are available.

4.1 Sources Tab

The "Sources" tab is used to add, edit, and delete sources within SPRAYTRAN. Although various source types are available, only area sources are used to simulate aerial spray drift within SPRAYTRAN. Once an area source has been created, it will appear on the source list within the "Sources" tab; each source appearing on the list can be edited and can be selected or deselected for use in the current simulation. Figure 4.1 shows an example "Sources" tab with the relevant controls labeled and an existing source populated in the source list.

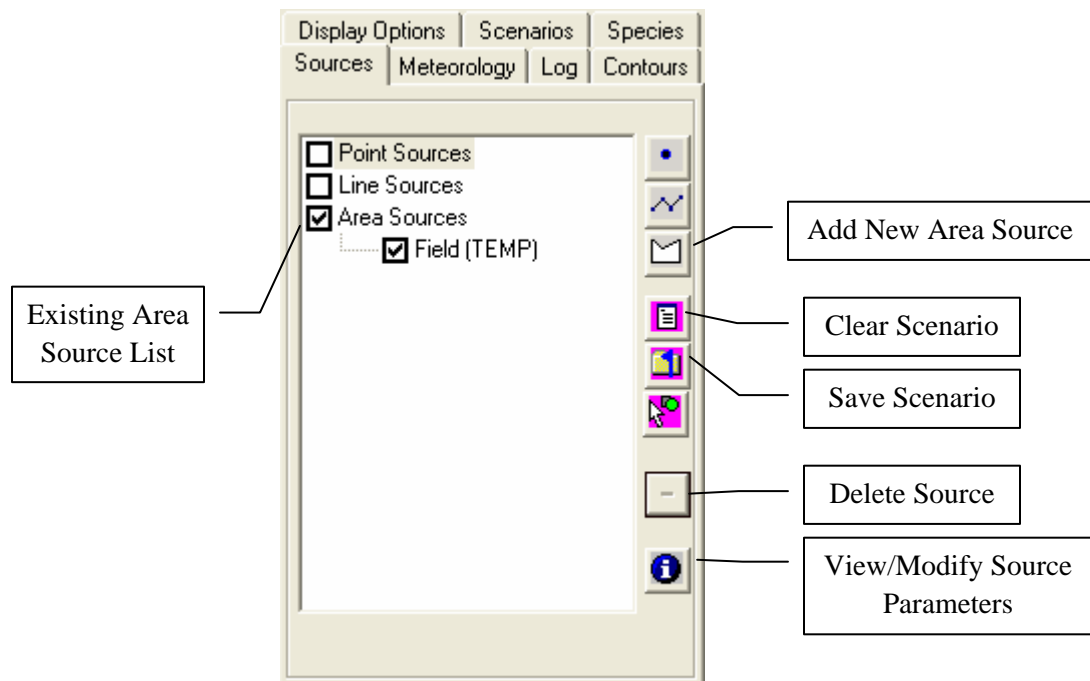



Figure 4.1. Example Sources Tab with Existing Area Source "Field" Entered

4.1.1 Adding a New Area Source

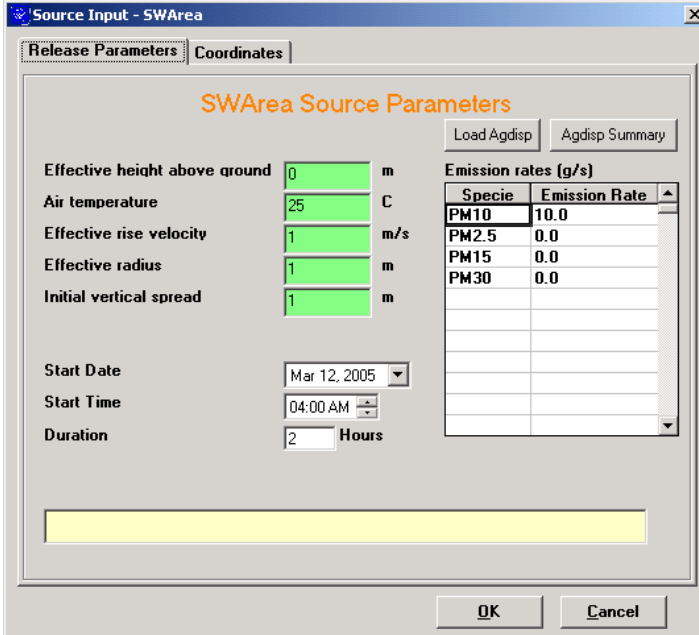
An area source is modeled as a four-sided polygon in SPRAYTRAN. A new area source can be added to a simulation by doing the following:

- Click on the “Area Source”  button. A prompt will appear directing the user to select a location in the ArcMap map window for the area source. Click “OK.”
- The mouse cursor will change to a crosshair. The area source is drawn as a polygon with four corners. To create the area source, click the mouse to create each of the four corners. On the last corner, double-click the mouse to complete the area source. Enter a name for the area source in the dialog box that appears and click “OK.”
- The area source will appear in the source list under “Area Sources” and will also be displayed within ArcMap.

A “Source Input” window will appear with two tabs—“Release Parameters” and “Coordinates.” The “Release Parameters” tab contains editable parameters that describe the release information for the area source. The “Coordinates” tab lists the UTM easting and northing coordinates for the source, and these coordinates are not editable.

4.1.2 Setting Area Source Release Parameters Manually

Once a new area source has been added or the name of an existing area source has been double-clicked on the “Sources” tab, the area “Source Input” window will be displayed. By default, the “Release Parameters” tab is selected and is used to enter characteristics of the area source, such as the effective release height above ground level and emission rates. Figure 4.2 displays an example “Release Parameters” form for an area source:



SWArea Source Parameters

Load Agdisp Agdisp Summary

Effective height above ground: 0 m

Air temperature: 25 C

Effective rise velocity: 1 m/s

Effective radius: 1 m

Initial vertical spread: 1 m

Start Date: Mar 12, 2005

Start Time: 04:00 AM

Duration: 2 Hours

Emission rates (g/s)	
Specie	Emission Rate
PM10	10.0
PM2.5	0.0
PM15	0.0
PM30	0.0

OK Cancel

Figure 4.2. Example Area Source Input Window Using the User Defined Emission Option

The following input parameters are available on the “Release Parameters” tab for an area source:

- Effective height above ground
- Air temperature
- Effective rise velocity
- Effective radius
- Initial vertical spread.

Default values are provided for each parameter. To change a parameter’s value, click on the textbox and enter a value. For quality assurance, textbox entries that are valid will appear green; invalid textbox entries will appear red. A range of valid entries appears in the yellow label at the bottom of the form for a given textbox entry.

Emission rates can be manually entered into the “Emission Rates” table on the “Release Parameters” tab, although most SPRAYTRAN applications will use AGDISP to generate the appropriate emission rate. By default, four species are listed in the table. Species can be added by clicking on the “Species” tab within SPRAYTRAN and following the steps to add a specie (see the DUSTTRAN User’s Guide). To manually add emission rates to the “Emission Rates” table:

- Click on the “Emission Rate” cell for a given “Specie” and enter its emission rate. If an “Emission Rate” is labeled “Not Selected,” the specie must be activated on the “Species” tab in SPRAYTRAN.

4.1.3 Setting Area Source Release Parameters through AGDISP Output Files

Output files created from an AGDISP simulation can be used in SPRAYTRAN to initialize area source release parameters. These files, including the AGDISP Input Summary File, Vertical Profile, and Deposition File, are read by the SPRAYTRAN interface and used to provide values for:

- Effective height above ground
- Air temperature
- Effective rise velocity
- Effective radius
- Initial vertical spread

and calculating a source emission rate.

To load the AGDISP files into the SPRAYTRAN interface and have the release parameter values automatically specified, click on the “Load AGDISP” button. Once the “Load AGDISP” button has been clicked, an information window will be displayed explaining the need to match the meteorological data used in the AGDISP simulation with the meteorological conditions entered for the SPRAYTRAN simulation. Figure 4.3 shows the information window that is displayed before the AGDISP data files are selected.

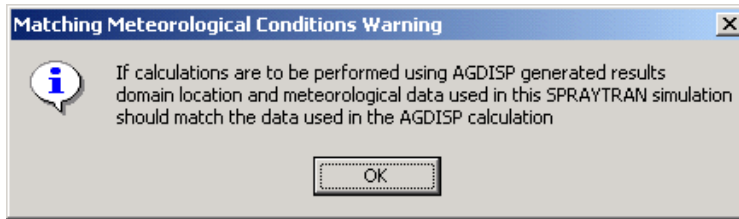


Figure 4.3. Meteorological Conditions Warning Window

- Click on the OK button to close the information window. A series of prompts will then be displayed asking for the location of the following AGDISP files:
 - input summary file
 - vertical profile file
 - deposition file.
- Navigate to the directory for each file and click the “Open” button to load each respective file.
- Following the selection of the input files, a prompt will be displayed asking for the specie name that will be associated with the calculated emission rate. Enter the desired name into the text box of the prompt window and then click on the “OK” button to enter the new name and close the prompt window.
- Once the new specie name has been entered, the name will appear in the species list of the area source input window along with the calculated emission rate. The new specie name will also be added to the species list of the “Species” tab found on the main interface of the SPRAYTRAN modeling system. Figure 4.4 shows the area source input window with the calculated emission rates entered.

4.1.4 Setting the Area Source Start Date, Start Time, and Duration

The area source “Start Date,” “Start Time,” and “Duration” are entered on the “Release Parameter” tab. This is the date, time, and total period the source emits material in the simulation.

Setting the Area Source Start Date

- To enter the date manually, click on the month, day, or year portion of the date displayed in the control. Once the appropriate portion of the date has been selected, the new value can be entered. All values should be entered as integers and are automatically checked for correctness. In the case of the month, it will convert the integer to the appropriate month/name abbreviation.
- To enter the date using the calendar control, first click on the dropdown arrow. A calendar will be displayed for the date that is currently entered in the “Start Date” control. To change years, click on the year label within the calendar and click on the up (down) arrows to increment (decrement) by 1 year. To change months, click on the right or left arrow buttons located at the top of the calendar control. Clicking on the left (right) arrow buttons decreases (increases) the month by one. To select a day, click on the desired day within the calendar, and the calendar control will then close with the “Start Date” input box automatically updating to the new date.

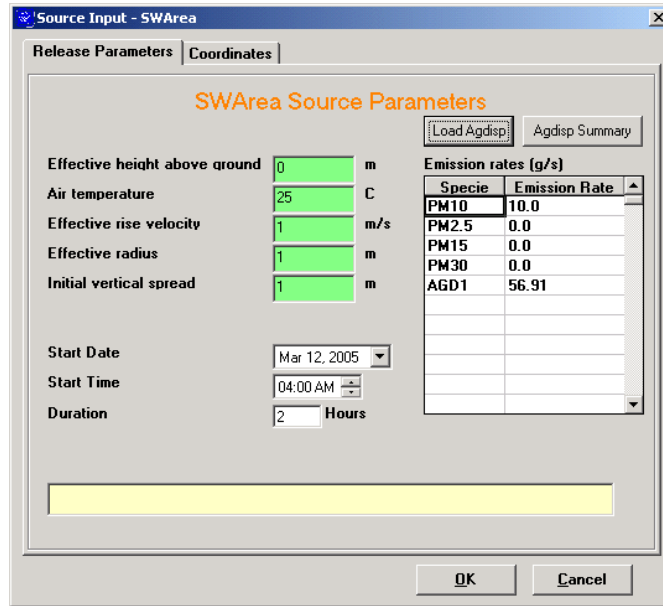


Figure 4.4. Example SPRAYTRAN Area Source Input Window with Calculated Emission Rate

Setting the Area Source Start Time

- Click the “Start Time” textbox and enter the hour value manually or click on the increase or decrease arrow buttons found to the right of the input box. Clicking the up-arrow (down-arrow) will increase (decrease) the time by 1 hour. Start times are currently limited to hour increments, and any minutes are ignored.

Setting the Area Source Duration

- Click the “Duration” textbox and enter an hour value manually or click on the increase or decrease arrow buttons found to the right of the input box. Clicking the up-arrow (down-arrow) will increase (decrease) the time by 15-minute intervals. Currently, the models simulate hour increments, and any minutes are ignored.

4.1.5 Creating Summary Input for AGDISP

If an AGDISP simulation has not yet been performed, recommended input parameters can be viewed by clicking on the “AGDISP Summary” button on the “Release Parameters” form for any area source in SPRAYTRAN. Summary information includes the coordinates of the vertices that make up the shape of the area source as well as user-specified meteorological data entered on the SPRAYTRAN “Meteorology” tab. Figure 4.5 shows an example of an area source input window with the AGDISP summary displayed.

The summary display also contains a “Flight Path Selection” calculator that can be used to determine the flight path angle to be used in the AGDISP simulation based upon the wind direction entered for the SPRAYTRAN simulation. Moving the scroll bar found underneath the flight-path calculator to the right will result in rotating the displayed flight path in a clockwise manner. As the displayed flight path is

rotated, the angle of the flight-path direction and wind direction will be automatically recalculated and displayed in the appropriate text boxes found beneath the flight-path calculator.

To return to the normal “Release Parameters” entry form, click the “Source View” button located at the bottom of the AGDISP summary (Figure 4.5).

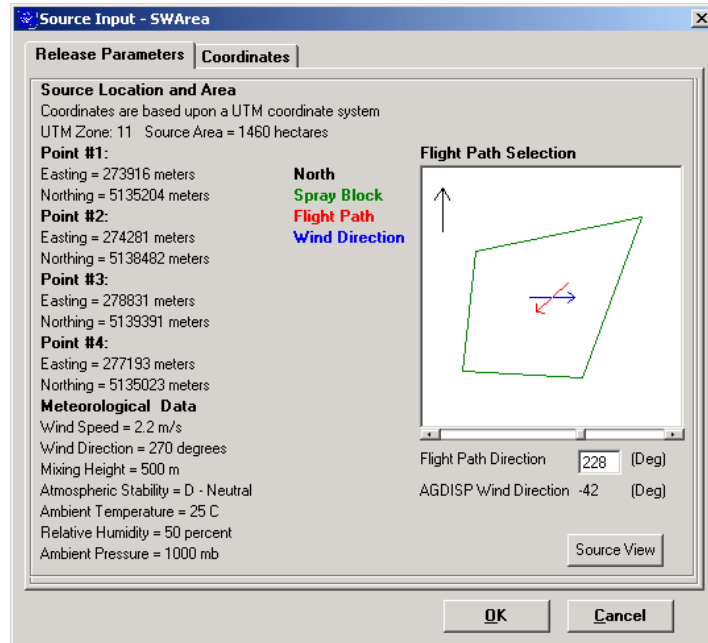


Figure 4.5. Example AGDISP Summary Display

5.0 SPRAYTRAN Example Tutorial

This section provides an in-depth example for simulating transport and dispersion of spray drift associated with material being released from an aircraft. The tutorial begins with using the FS's AGDISP software to generate the on- and near-field concentration and deposition field from an aerial spray application for a defined forest block. The results from AGDISP are then used in SPRAYTRAN to initialize an area source to simulate the longer-range, offsite transport and dispersion of the drift associated with the initial spray application.

This tutorial requires both the AGDISP and SPRAYTRAN software applications to already be installed. Information regarding the installation of AGDISP can be found in the AGDISP User's Manual (Teske and Curbishley 2002). Information regarding the installation of SPRAYTRAN and the sample site can be found in Section 3.0 of this User's Guide.

This tutorial assumes the user is familiar with the intended application and use of the AGDISP and SPRAYTRAN software. In short, AGDISP is used to simulate the near-field transport and dispersion of drift from aerial spray applications. SPRAYTRAN uses the results from AGDISP to initialize area source-term parameters to simulate longer range transport within a GIS interface using the state-of-the-science CALifornia METeorological (CALMET) model (Scire et al. 2000b) and the CALPUFF dispersion model. Section 2.0 of this User's Guide provides a detailed overview of the AGDISP and SPRAYTRAN software applications, including their linkage.

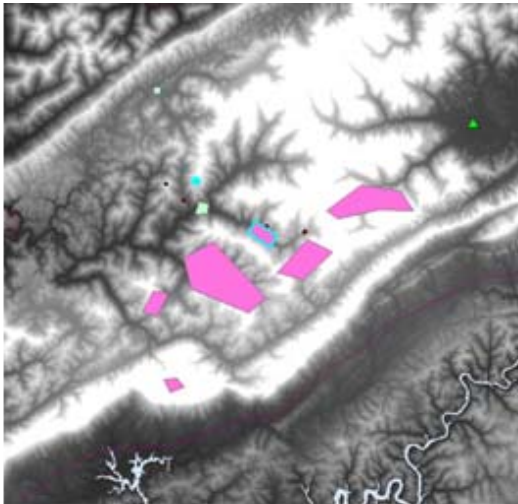
5.1 Scenario Overview

To illustrate the use of AGDISP and SPRAYTRAN, as well as the linkage between the systems, an example case is presented that is based on an application to an actual spray block located in north-east Tennessee. In this example, a forested area is to be sprayed. The spray block is 123 hectares ($1.23 \times 10^6 \text{ m}^2$ or 304 acres). Figure 5.1 (left panel) shows the example case spray block (highlighted in cyan) in addition to a number of other surrounding spray blocks. The example spray block is rotated (right panel) to a vertical orientation and fit to a rectangular shape with sides of about 800 and 1540 m (2630 and 5040 ft).

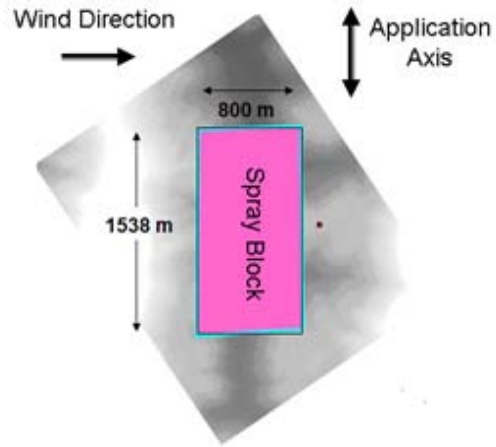
The example case shown in Figure 5.1 assumes that the application path will be along the longer dimension of the block (1540 m) and that the application is assumed to be performed when the wind direction is at right angles to that application direction. The aircraft performing the spraying is an Air Tractor AT-401 and has an effective swath (spray) width of 18.29 meters. Therefore, the number of required swaths to cover the 800-m length is computed as 44 (length of area divided by the effective width of swaths). Table 5.1 summarizes these and other major input parameters.

The details of spray direction and wind direction generally do not greatly affect the magnitude of the net residual airborne emission rate used in SPRAYTRAN. There are many possible combinations involving rotation of the area, approximation of the block shape with a rectangle, and the use of relatively arbitrary application setup directions as well as ambient conditions that will produce equivalent spray applications. Users can confirm this for their specific applications by testing several configurations.

The spray area defined in this example is small enough that it can be modeled in one AGDISP simulation. Multiple spray blocks that might result from complex block shapes, irregular terrain, or multiple application areas (such as the surrounding blocks shown in Figure 5.1) need to be modeled as separate block runs in AGDISP. The results from each spray block can then be used to create a single scenario in SPRAYTRAN to examine the cumulative effects from all the blocks.



SPRAYTRAN Modeling System
Example Case. Spray block areas are shown on a regional map as pink areas with the example case outlined in blue.



Example Case Spray Block Area. Area is shown rotated with dimensions, wind direction, and axis direction labeled.

Figure 5.1. Details of Example Case

Table 5.1. Tabular Summary of SPRAYTRAN Modeling System Example Case Parameters

Parameter	Value	Units	Information Source
Application area	123	hectares	User defined.
Rectangular area length	800	m	Values are based on a “best fit” of the actual area shape to a rectangular area.
Rectangular area width	1540	m	Values are based on a “best fit” of the actual area shape to a rectangular area.
Effective swath width	18.29	m	Characterization of the spray technology and application details defines the effective width of swath.
AGDISP Application Axis Direction	0	degrees	User selected. Example case assumes the application is along (i.e., parallel to) the 1540-m spray block length.
AGDISP Wind Direction	-90	degrees	Defined relative to application direction.
Number of swaths	44	(none)	Number of swaths required to cover length of example area.

5.1.1 Creating and Running a Simulation in AGDISP

AGDISP is a separate software application that is used to generate the necessary release parameters for SPRAYTRAN so that the effects of long-range transport and dispersion on spray drift can be assessed. AGDISP contains a comprehensive library of aircraft types, application techniques, spray material, and near-field transport algorithms, which makes it ideal for analyzing short-range impacts and initializing area source-term information in SPRAYTRAN.

This section provides key AGDISP parameters related to specific site characteristics and computation options that must be defined properly to link the results to SPRAYTRAN. It is assumed that the user has some understanding of how to use AGDISP to analyze spray applications and is not meant to be a comprehensive tutorial on the use of AGDISP. Users are encouraged to reference the AGDISP User Manual (Teske and Curbishley 2002) for additional information on specific options, features, and parameters within AGDISP.

5.1.1.1 Starting AGDISP

After installing AGDISP, it is available for use by selecting “AGDISP” from the Windows “Programs” menu. Figure 5.2 shows the primary input screen for AGDISP. By default, many of the input parameters are already defined. This example is based on modifications to the default parameters distributed with AGDISP.

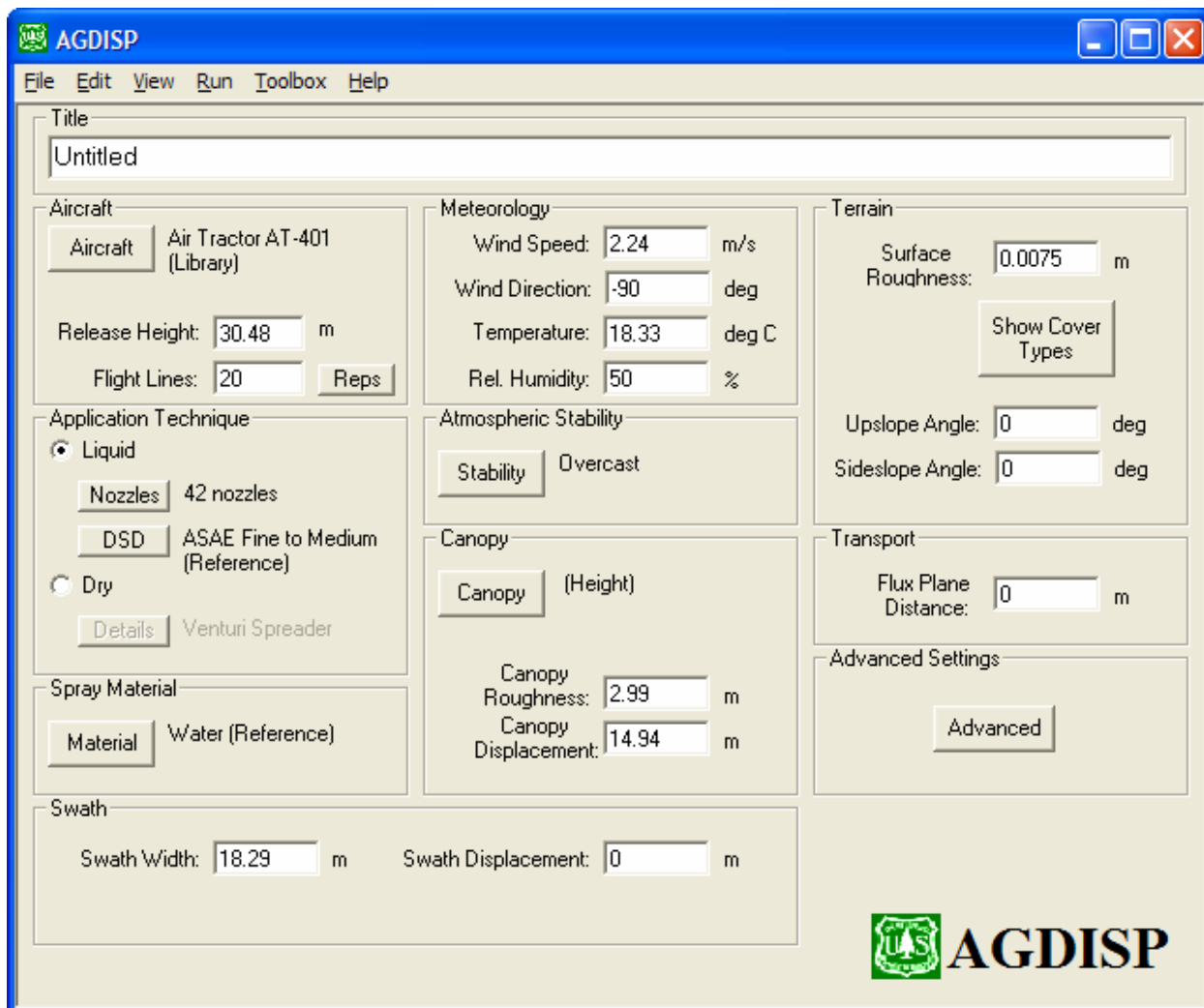


Figure 5.2. Initial Main AGDISP Screen with Distribution Parameters (metric units)

5.1.1.2 Setting Default Units to Metric

AGDISP allows user entries and model output results to be in either English or Metric units. SPRAYTRAN expects metric output, and so it is extremely important to verify that metric units are being used in AGDISP. To set the units to metric in AGDISP:

- Select the “Edit” menu and choose the “Preferences” option.
- Change the “System” units to “Metric.”
- Set “Deposition” mass units to “g” and area units to “m²”.

The preferences form with the correct unit selection is shown in Figure 5.3.

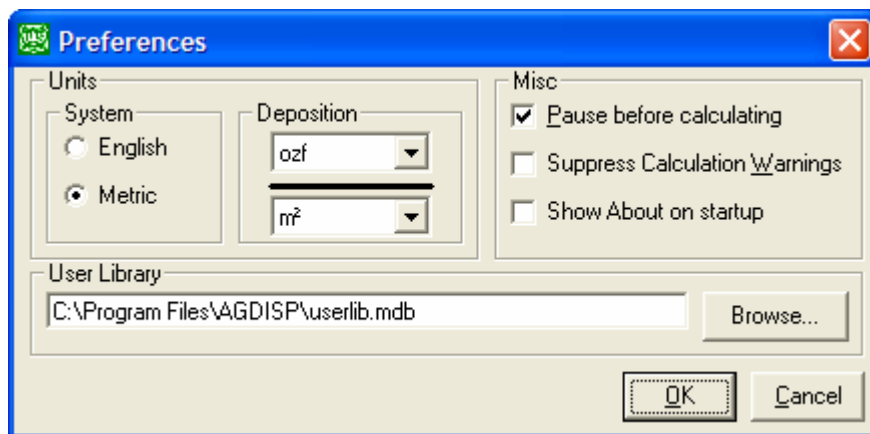


Figure 5.3. AGDISP Preferences Screen Set to Metric Units

5.1.1.3 Modifying Default AGDISP Input Parameters

Certain default parameters on the primary user-entry form for AGDISP will be modified in this section to more accurately represent the current scenario. Other parameters, such as the selection of “Aircraft” type and “Application Technique,” are beyond the scope of this tutorial and are not changed beyond the default values. However, the user is encouraged to view and experiment with the available settings in AGDISP.

The parameters to be modified for this example are as follows. Figure 5.4 displays the final, modified AGDISP form:

- **Title:** Enter descriptive title for the analysis case. For the example case, enter “SPRAYTRAN Example Case.”
- **Flight lines:** Enter the number of swaths required to cover the area. For our example case, enter the value 44, which was computed previously in the description of the spray block area (see Table 5.1).
- **Wind speed:** Enter a wind speed that will be typical during the application. For the example case, the value of 2.24 m/s is used.
- **Wind direction:** Enter the angle of application relative to the ambient winds. This parameter is set to -90 deg in the example case. (*Note:* the value of this parameter is not expected to greatly change the net “residual” active chemical agent airborne emission rate defined for use in the SPRAYTRAN interface.)
- **Temperature:** Enter an air temperature that will be typical during the application. A value of 18.33 deg C is used in the example case. (*Note:* Although this parameter will not be directly important in the SPRAYTRAN dispersion computations, the value of this parameter can have an influence on other data imported from AGDISP in terms of evaporation rate computations.)
- **Relative Humidity:** Enter typical relative humidity for the application period. A value of 50% is used in the example case. (*Note:* Although this parameter will not be directly important in the SPRAYTRAN dispersion computations, the value will have an influence of the droplet-size distributions output from AGDISP in terms of evaporation rate computations.)
- **Atmospheric Stability:** Select either day or night conditions along with expected surface heating/cooling situations. “Nighttime” with “overcast” conditions is selected for the example

case. (Note: Stability is used in dispersion modeling to represent the ambient atmospheric turbulence intensities. AGDISP and the SPRAYTRAN air dispersion modules use equivalent definitions of stability. AGDISP defines stability in terms of the time of day and meteorological conditions. The air dispersion modules in SPRAYTRAN define stability in terms of stability categories where A-C are unstable (rapid mixing), D is neutral, and E-F are stable (slow mixing). The AGDISP stability designation combined with the wind speed is mapped to the conditions for the lettered stability categories in Table 5.2 below. For the example case, the nocturnal overcast designation indicates D category conditions for all ambient wind conditions).

- Transport:** Enter the “Flux Plane Distance.” A value of 200 m should be entered for the example case. (Note: 200 m is the recommended value for this parameter for generating input files for the SPRAYTRAN interface. The drift droplet-size distribution is defined at this distance.)

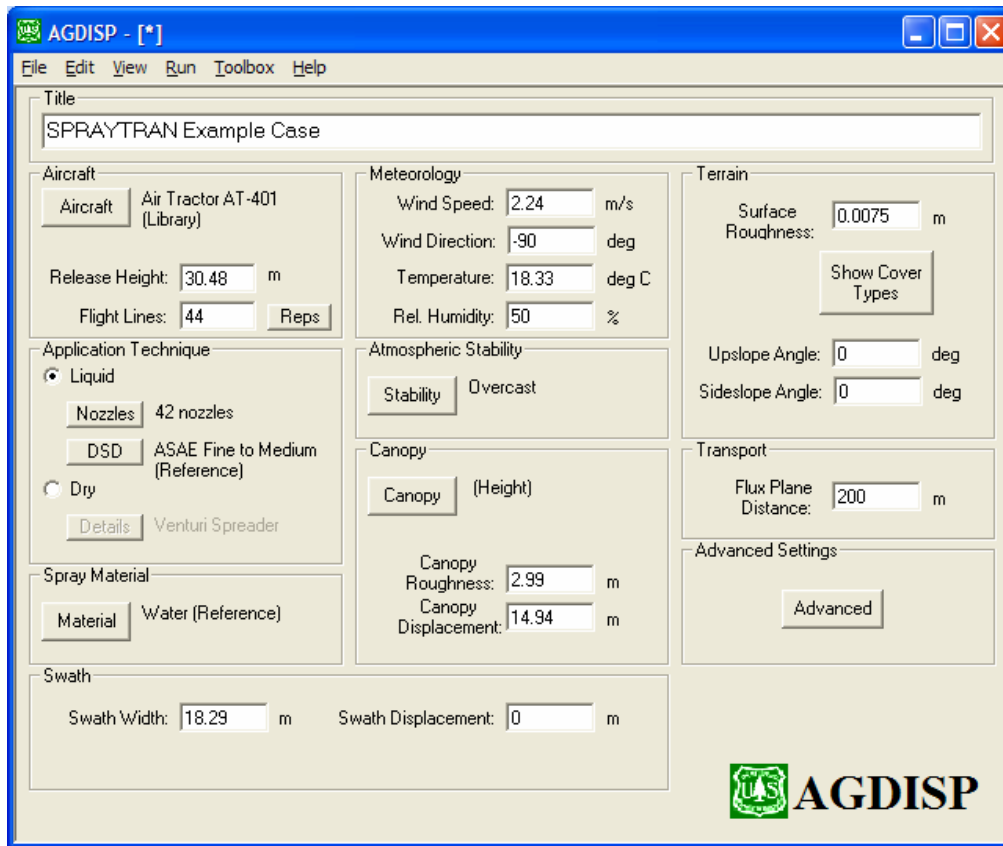


Figure 5.4. Main AGDISP Screen with Example Case Parameters (metric units)

- Advanced Settings:** By clicking on the “Advanced” button, there are a number of high-level parameters that can be modified in AGDISP. Set the “Maximum Downwind Distance” to a value of 200 m (Figure 5.5). (Note: The 200-m distance is the recommended value for this parameter for generating input files for the SPRAYTRAN interface. The fraction of “residual” active chemical remaining aloft as drift is defined at this distance).

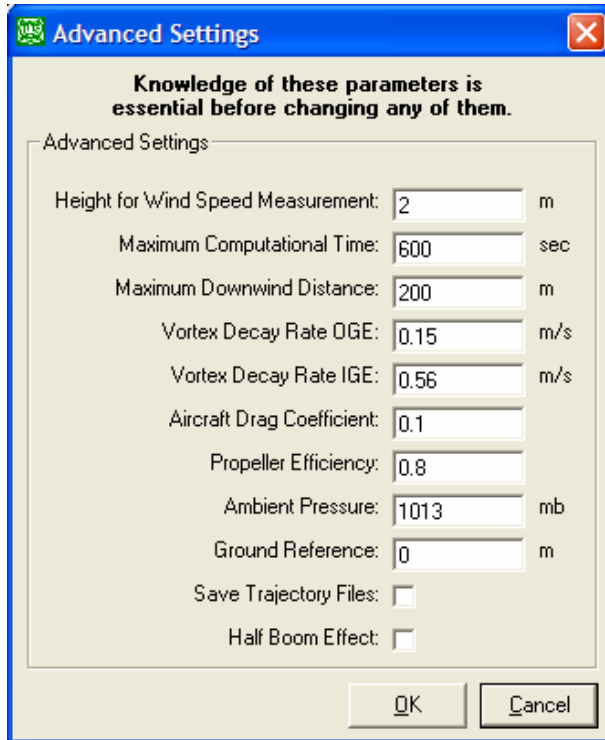


Figure 5.5. AGDISP Advanced Setting Screen with Example Case Parameters

Table 5.2. Relationship Between Turbulence and Weather Conditions^(a)

AGDISP Weather Conditions Selection		SPRAYTRAN Inputs				
		Pasquill-Gifford Stability Category				
		Ambient Wind Speed (m/s)				
		<2	2	4	6	>6
Day (1 hour after sunrise to sunset)	Isolation (sunshine)	A	A/B	B	C	C
	Strong	B	B	B/C	C/D	D
	Moderate	C	C	C	D	D
	Slight	D	D	D	D	D
	Weak	D	D	D	D	D
Night (sunset to one hour after sunrise)	Cloud cover	D	D	D	D	D
	Overcast	D	D	D	D	D
	Thinly overcast	E	D	D	D	D
	Less than $\frac{3}{8}$ overcast	F	E	D	D	D
Stability Categories:						
A: Extremely unstable conditions		D: Neutral conditions				
B: Moderately unstable conditions		E: Slightly stable conditions				
C: Slightly unstable conditions		F: Moderately stable conditions				
(a) Based on tables in Randerson (1984).						

5.1.1.4 Running AGDISP

After all the input parameters have been set, AGDISP is ready to perform a simulation. To run AGDISP:

- Select the “Run” menu and choose the “Run Calculations” option. AGDISP will verify the accuracy and ranges for certain user entries. An informational message for the “Maximum Downwind Distance” may appear. If such a window appears, select “Yes” to continue with the calculations, as the linkage calculations may be conducted at distances outside the typical range of AGDISP usage.
- When the “AGDISP Calculations” window appears, select “Start.” After the application completes the run, use the “Close” button to return to the primary AGDISP screen.

5.1.1.5 Saving AGDISP Input and Output for Use in SPRAYTRAN

The AGDISP input file and certain model output files are used to initialize the release parameters for area sources in SPRAYTRAN. In this section, these relevant files generated by AGDISP will be saved for use in SPRAYTRAN.

- **Save AGDISP Input File for Use in SPRAYTRAN:** From the main AGDISP menu, select “File” and choose “Save” or “Save As” to save the AGDISP input parameters entered in the current application case. For the example case, enter “ExCase” as the file name (Figure 5.6). This file is used by SRAYTRAN but also allows the current scenario to be reloaded into AGDISP at a later time.

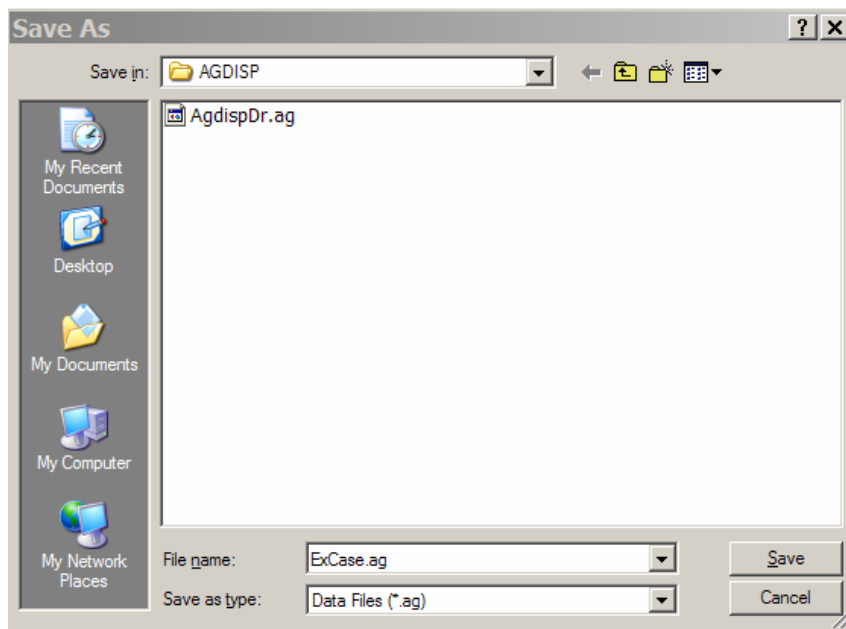


Figure 5.6. AGDISP Input File Save Operation

- **Save AGDISP Output Files for use in SPRAYTRAN:** The source-term initialization for SPRAYTRAN requires two AGDISP output files—a Summary File and a Profile File. These files should be saved in a directory where they can be easily located for use in the SPRAYTRAN interface. When making many runs for multiple blocks in AGDISP, it is recommended that a special sub-directory be made for saving the AGDISP output files.
 - **Summary File:** From the main AGDISP menu, select “View” and choose “Input Summary.” Figure 5.7 shows the “Input Summary” window. Select the “Save” button at the bottom of this window. A “Save As” dialog will open; enter an appropriate file name and directory for the summary file. For our example case, enter “ExCaseSummaryFile” and select “Save.” Then select the “OK” button to return to the main AGDISP menu.

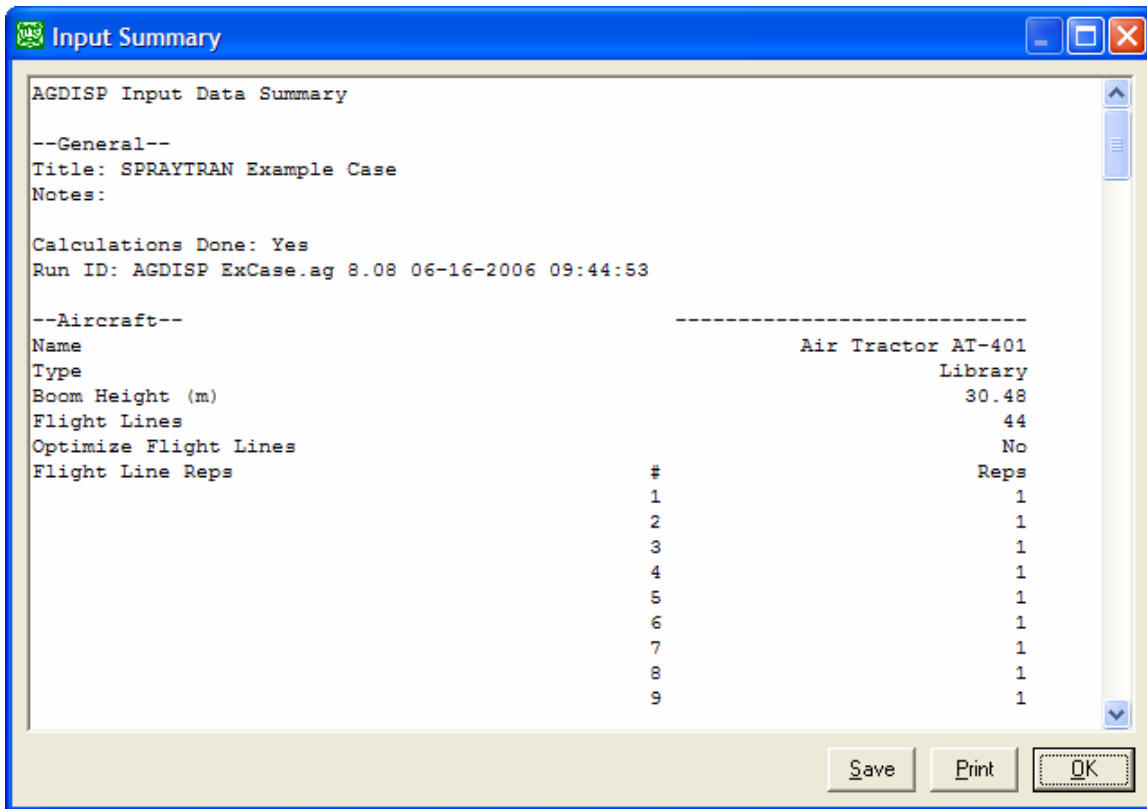


Figure 5.7. Input Summary Screen

- **Profile File:** From the main AGDISP menu, select “View” and choose “Numerical Values.” The “Numerical Values” window, shown in Figure 5.8, will appear. Under the “Drop Size Distribution” panel, select “Vertical Profile” from the listbox. Figure 5.8 will display the vertical profile results for the “Flux Plane Distance.” Select the “Save” button at the bottom of the screen. A “Save As” window will open; enter an appropriate file name and directory for the profile data file. For the example case, enter “ExCaseProfileFile” and select “Save.” Then select “OK” to return to the main AGDISP window.

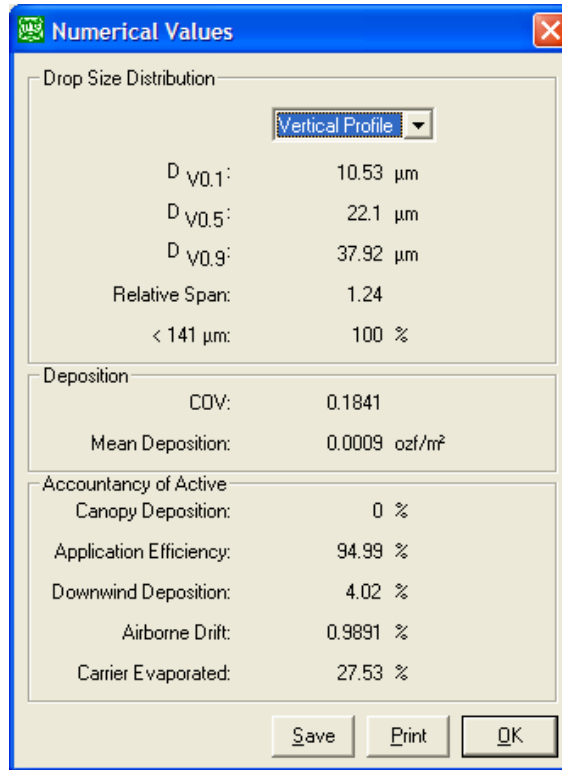


Figure 5.8. Numerical Values Screen

5.1.1.6 Creating AGDISP Deposition Plot for Comparison in SPRAYTRAN

Deposition plots from AGDISP can be saved for visual comparison in SPRAYTRAN. Currently, a limited graphic representation of the AGDISP deposition plots is implemented in SPRAYTRAN, and the user is directed to use the actual AGDISP plots for visualization of the AGDISP, near-field deposition patterns. Although the deposition data are not used in the definition of the SPRAYTRAN source term, the SPRAYTRAN interface requires that a deposition file exist when AGDISP data are imported. A base-case deposition file (i.e., file from the initial case) can be used for all runs, with the understanding that the imported AGDISP plot applies only to the base case. This practice is particularly useful when analyzing an application involving multiple spray blocks using the same application method and approach.

To create an ADISP deposition plot:

- From the AGDIP main menu, select “Toolbox” and choose “Spray Block Details” as shown in Figure 5.9.

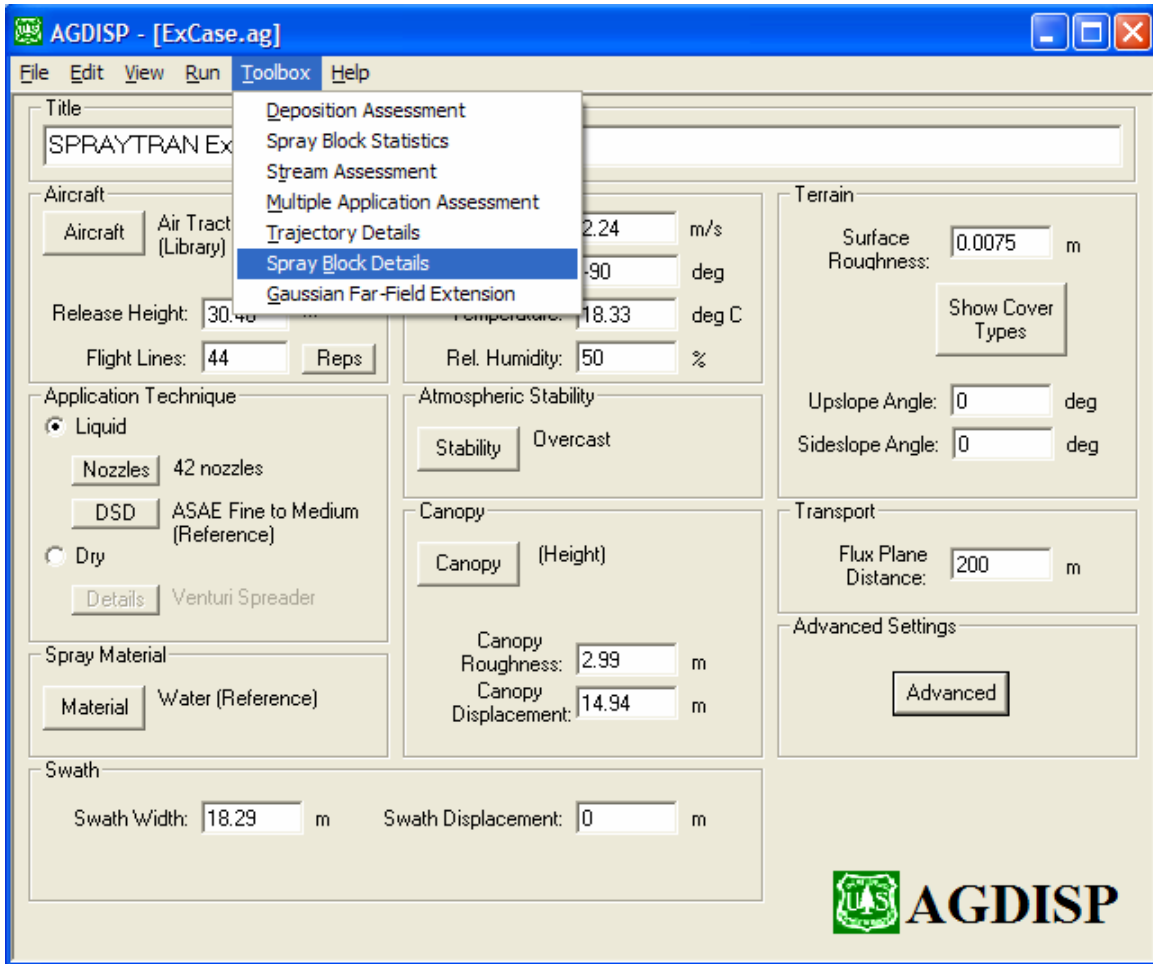


Figure 5.9. Selecting Spray Block Details

- The “Spray Block Details” window will appear (Figure 5.10) and provides the capability of applying the application base case defined in the main AGDISP window to other application configurations. Set the parameters in this window as follows:
 - **Units:** Select “g” and “m²”.
 - **Component:** Select “Active.”
 - **Flight Direction:** Set to “0” deg.

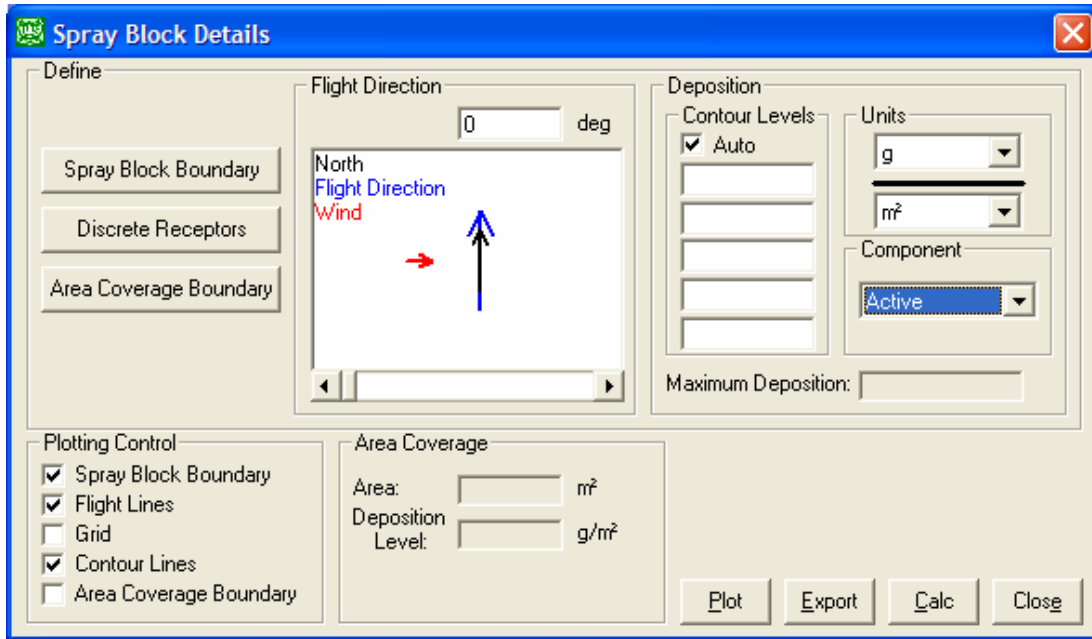


Figure 5.10. Spray Block Details Option

- Click the “Spray Block Boundary” button; the “Spray Block Boundary” window will appear (Figure 5.11). The coordinates of the corners of a rectangular representation of the area are entered as a series of (x, y) values. For linkage to the SPRAYTRAN interface, a local coordinate system is used with the spray block lower left corner at the origin (0,0). For the example case, enter the x-length value of 800 m and the y-length value of 1540 m as shown to define the other corners of the rectangular area. Then select the “OK” button to return to the “Spray Block Details” window.

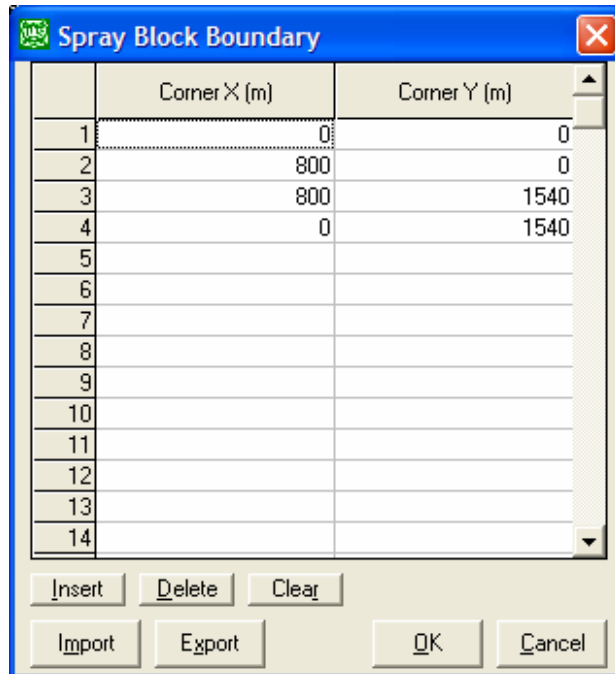


Figure 5.11. Spray Block Boundary

- In the “Spray Block Details” window, click the “Calc” button to start a re-computation for the new area configuration that has been entered. Then, click the “Plot” button to display the results graphically, as shown in Figure 5.12. Select the “Close” button to return to the “Spray Block Details” window.

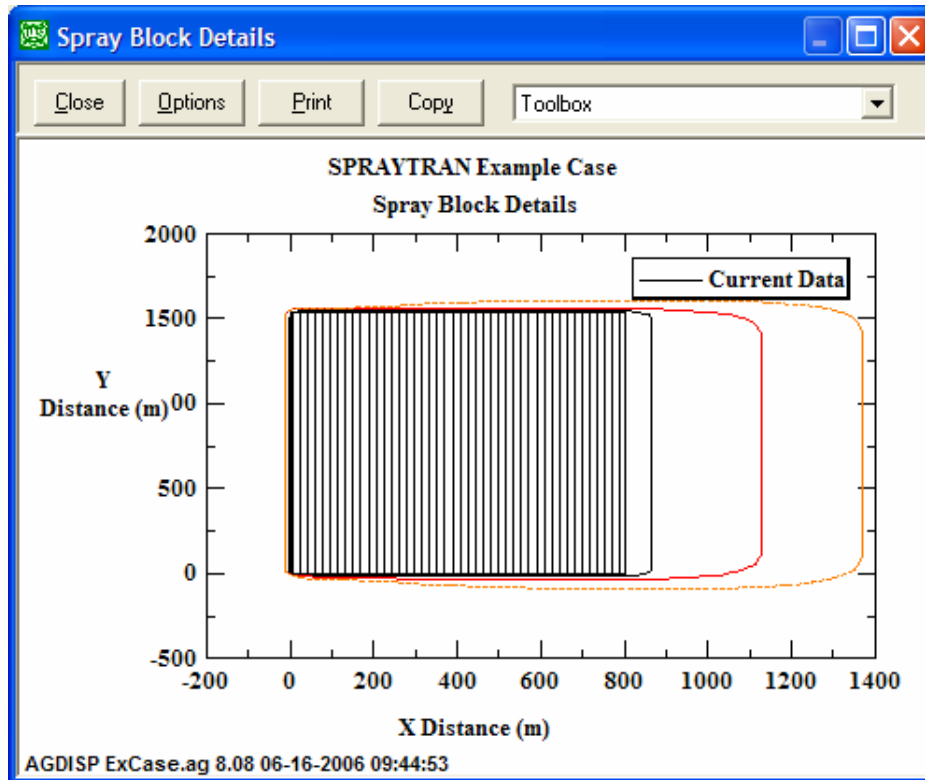


Figure 5.12. Spray Block Boundary

- From the main “Spray Block Details” window, select the “Export” button. A “Save As” window will open (Figure 5.13). Enter an appropriate file name and save the file in the same directory that is used to save the other AGDISP output files. For the example case, enter “ExCaseDeposition” and select “Save.”

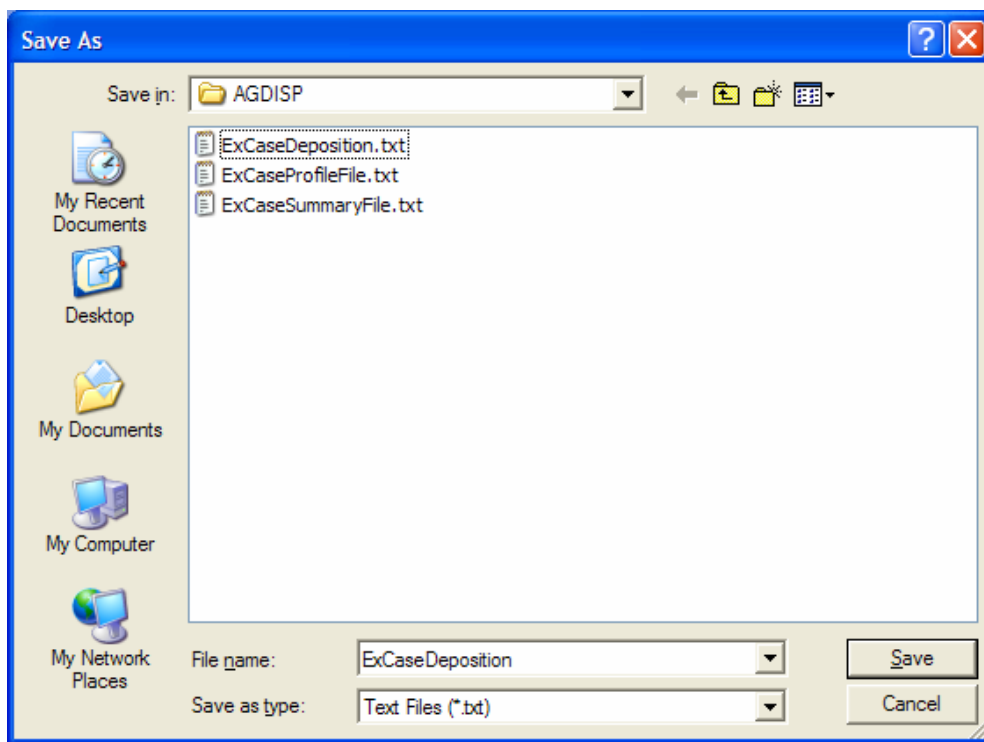


Figure 5.13. Deposition File Save Screen

- Click the “Close” button on the “Spray Block Details” window to return to the main AGDISP interface. The options selected and data entered in the “Spray Block Details” screens are not stored by AGDISP, so the run options and input data must be re-entered each time the “Spray Block Details” window is accessed.

This completes the steps required for entering information in and exporting data from AGDISP to be used in the SPRAYTRAN interface. The AGDISP application can be closed by selecting “Exit” from the “File” menu.

5.1.2 Creating and Running a Simulation in SPRAYTRAN by Importing AGDISP Results

SPRAYTRAN, an extension of the DUSTRAN dust-dispersion modeling system, is designed to consider the transport and dispersion of drift from forestry and agricultural spraying operations. The SPRAYTRAN interface includes the option of defining area source-term parameters with spray block application data from AGDISP.

This section provides step-by-step instruction for setting up a simulation in SPRAYTRAN and using the AGDISP results (from Section 5.1.1) to initialize the area source-term parameters. This section supplements the general application guidance for operating the SPRAYTRAN modeling system found in Section 4.0 of this User’s Guide and Section 4.0 of the DUSTRAN User’s Guide (Allwine et al. 2006).

The SPRAYTRAN modeling system requires an estimate of the total amount of “residual” active chemical drift and does not explicitly use, or consider, the direction of flight path or other similar details of application coverage that are required in AGDISP. It is assumed in SPRAYTRAN that applications actively cover the spray blocks.

Once an AGDISP analysis is complete using the steps described in Section 5.1.1, the data from the AGDISP interface are ready to be imported into the SPRAYTRAN interface. As noted earlier, three files are saved in the AGDISP interface for use in the SPRAYTRAN. These three files—Inputs Summary Data, Calculated Profile Data, and AGDISP Deposition Results—are used to initialize the source-term input parameters for the area source that defines the spray block in SPRAYTRAN.

5.1.2.1 Starting SPRAYTRAN

To start an analysis in SPRAYTRAN, go to the Windows “Programs” menu and launch ArcMap. When ArcMap is loaded, click the “SPRAYTRAN” button located on the toolbar. This launches the SPRAYTRAN application within ArcMap (Figure 5.14).

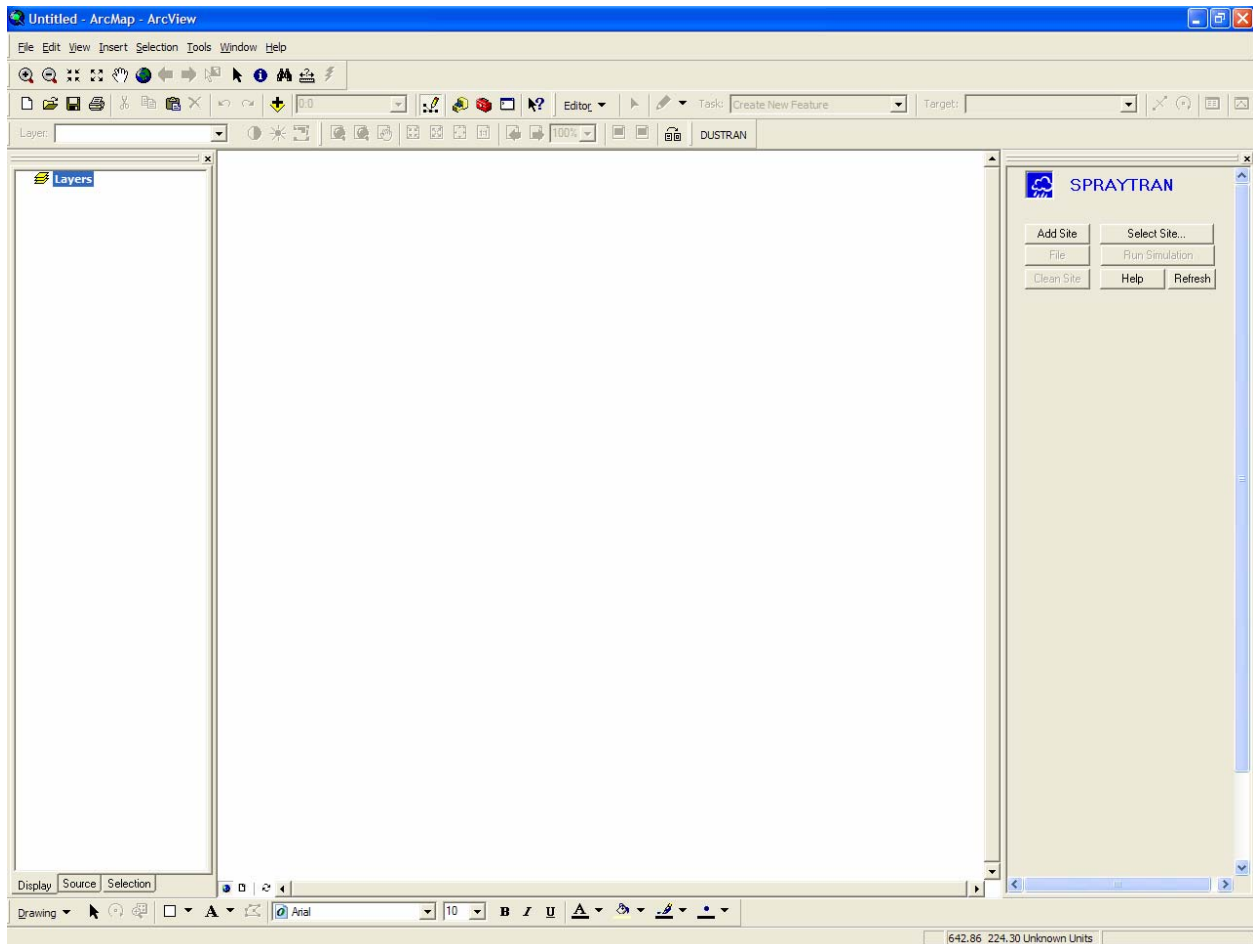


Figure 5.14. Main SPRAYTRAN Interface Screen at Startup

5.1.2.2 Selecting a Site

Once SPRAYTRAN has been started, a site can be selected and loaded into the interface. A site contains existing geospatial and geophysical data layers that can be displayed in ArcMap and is used to spatially define the location of the model domain and source locations in SPRAYTRAN. To select a site:

- Click the “Select Site” button on the SPRAYTRAN console. A “Configuration” window will open (Figure 5.15).
- Select the site to be modeled from the site list. For this example case, select “Tenn” for the Tennessee site (see Section 3.2 for installing the example site). The site will be loaded and displayed in ArcMap, and previously defined parameter values for this site will be displayed in the SPRAYTRAN interface, as shown in Figure 5.16.

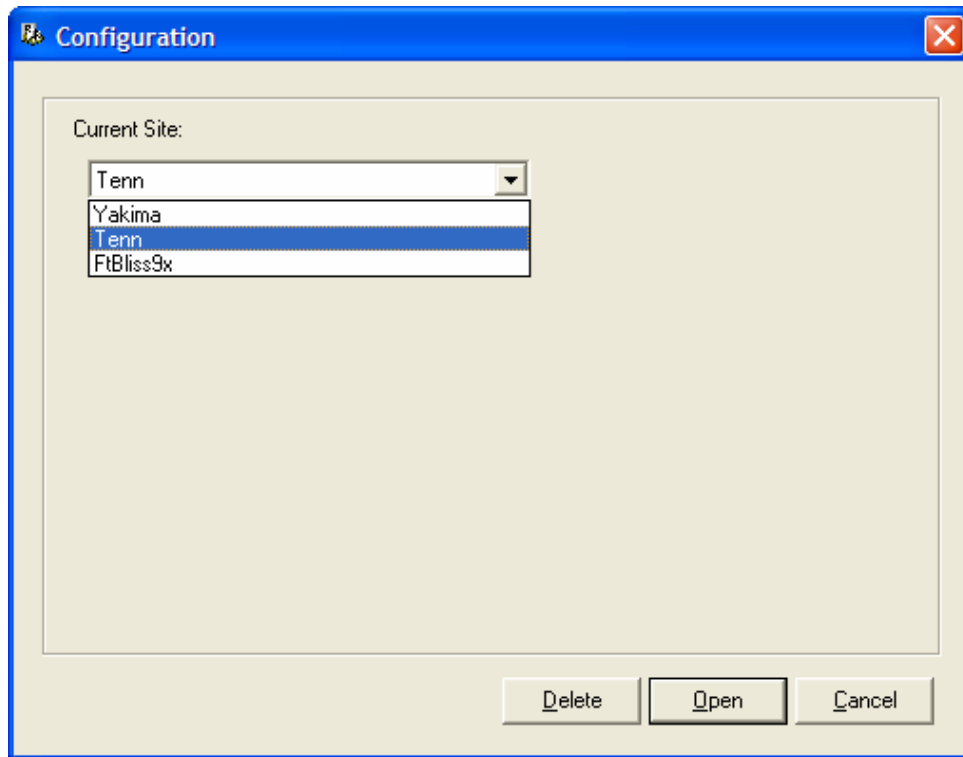



Figure 5.15. Select Site Window

5.1.2.3 Setting SPRAYTRAN Simulation Parameters


After loading the Tennessee site into SPRAYTRAN, existing input parameters, such as the model domain “Name,” automatically populate fields within the interface. This section reviews the SPRAYTRAN input parameters and makes modifications to define the current scenario.

- **Domain:** The Domain/Name should be set to “AGDISP” and the Domain/Size set to 20 km (Figure 5.16).
- **Release Period:** By default, the release “Start Time” is 4:00 a.m. and the “Release Period” is 2 hours. These values can be changed on individual source forms when the source is created.
- **Simulation Scenario:** Set the “Simulation Type” to Source Emissions, a “Start Date” of July 1, 2005, a “Start Time” of 4:00 a.m., and a “Run Duration” of 4 hours (Figure 5.16). (*Note:* The “Simulation Type” must always be set to “Source Emissions” for simulating spray drift in SPRAYTRAN).

- Meteorology Tab:** The “Meteorology” tab is used to define the meteorological conditions that exist at the time of the spray application. For this scenario, “Single Observation” should be selected. Click the “Information” button  to open the window for entering a single observation.

The “Single Observation” meteorological form is populated automatically with default data (Figure 5.17). These data are equivalent to the data used in the example AGDISP run (Section 5.1.1), except wind direction, which is defined differently in AGDISP and SPRAYTRAN.

- Sources Tab:** The “Sources” tab is used to add, edit, and delete sources in a SPRAYTRAN simulation. This section describes the method for adding an area source in SPRAYTRAN that will be used to define the spray block.

To add an area source, click on the “Sources” tab and click on the “Area Source” button  (Figure 5.18). The area source is defined by drawing a four-sided polygon in the ArcMap map window. The process of defining a new area source (spray block) is aided by using a predefined, site-specific shapefile, called “Shape Blocks.” This layer can be displayed by checking the box next to the “Shape Blocks” layer in ArcMap.

The area source is created by clicking on each corner of the polygon shape that defines the spray block. The final corner is double-clicked to close the polygon. If a spray block has more than four sides, then the area should be approximated by a four-sided polygon in SPRAYTRAN. For the example case, the area outlined in blue should be used (Figure 5.19). This area is the same area as used in the analysis above using AGDISP, and will be loaded in the next step with the “Scenarios” tab.

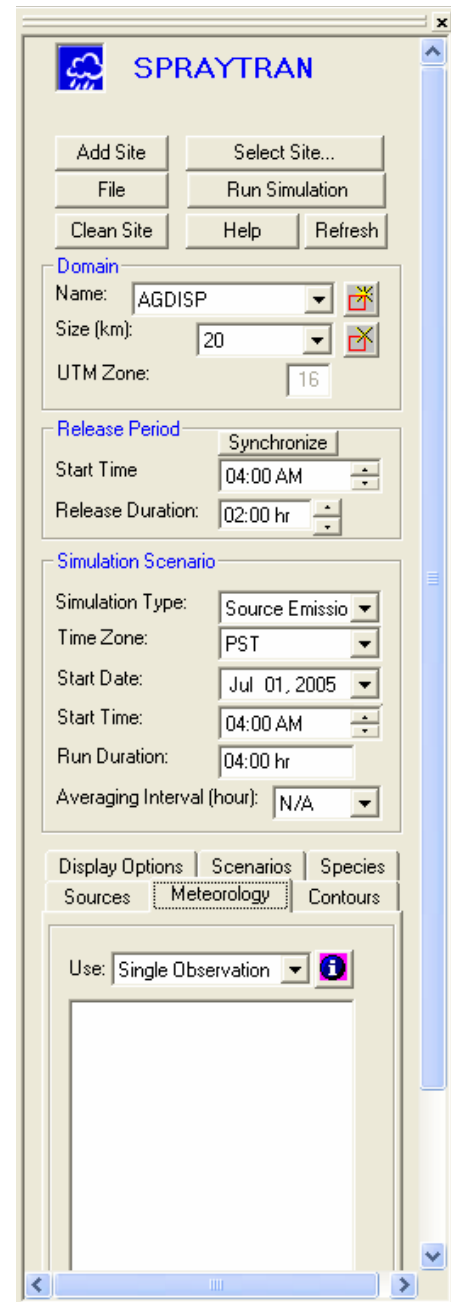


Figure 5.16. SPRAYTRAN Example Case

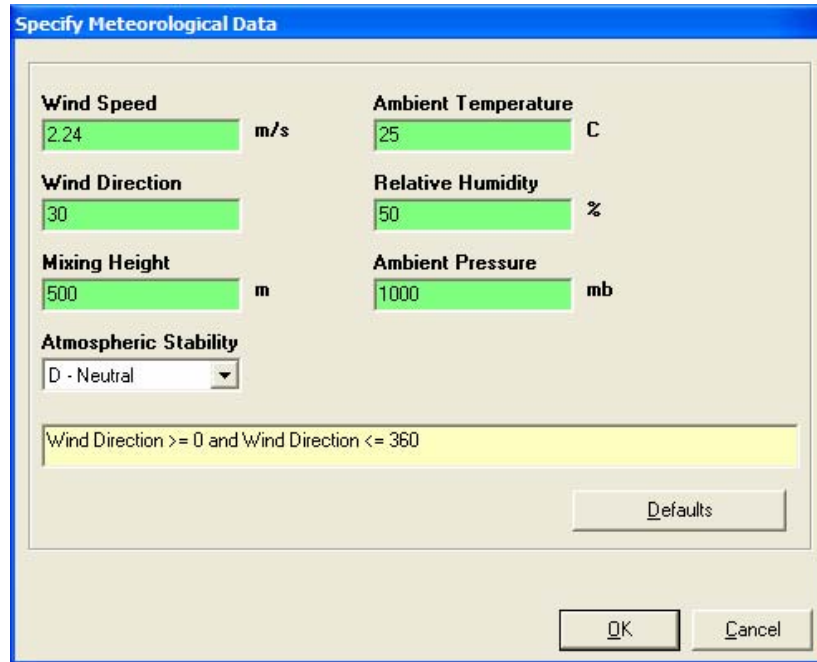


Figure 5.17. Example Case Meteorological Data

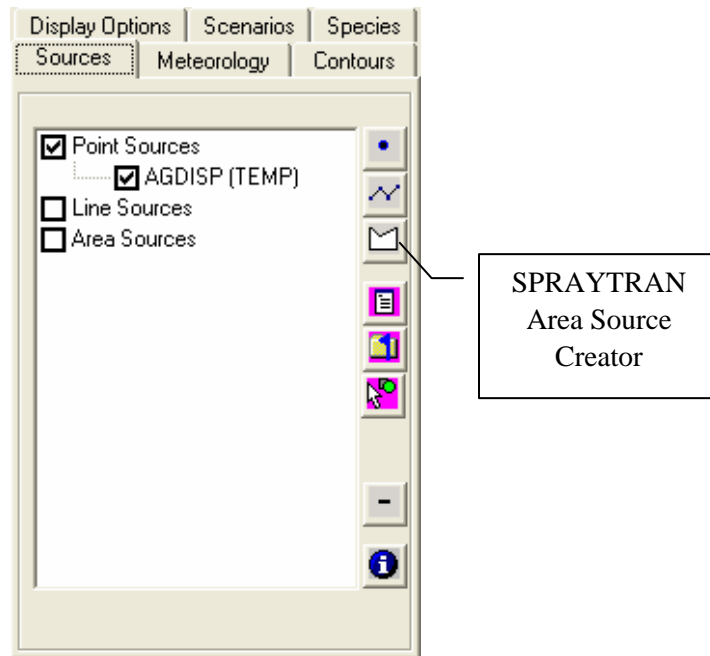


Figure 5.18. Example Define Source Area

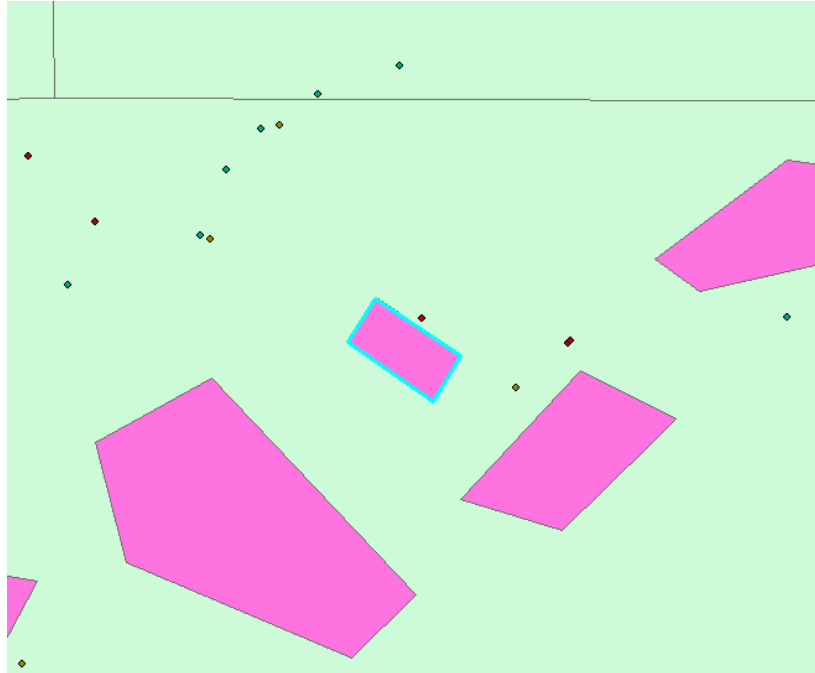



Figure 5.19. Example Case Spray Block Areas Displayed in SPRAYTRAN

- **Scenarios Tab:** Previously defined area source(s) can be loaded into SPRAYTRAN by selecting the “Scenarios” Tab. A list of “Available Sources” is displayed on this tab. To load a scenario, highlight the desired source scenario name and click the “Add Scenario”  button to load that scenario.

For the example case, select “TForest” from the scenario list. The source will be added to the current simulation and will be listed as an available area source (called “ForestBlk”) on the “Sources” tab. In addition, the source will be outlined in blue in the ArcMap map window.

5.1.2.4 Viewing and Editing Source Information in SPRAYTRAN

Once the scenario has been added, the area source “ForestBlk” will appear on the “Sources” tab (Figure 5.20). A check in the checkbox next to the source name means the source will be used in the current simulation. To view the parameters for a particular source, double-click on the sources name in the source list.

The “Source Input” window, shown as Figure 5.21, shows the parameter values for the example area source. The entries for emission rates are explained below and may not be identical to the figure at this point in the tutorial.

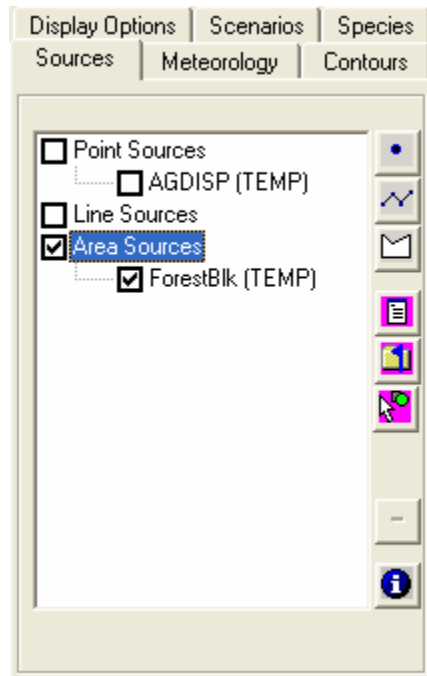


Figure 5.20. Sources Tab Window

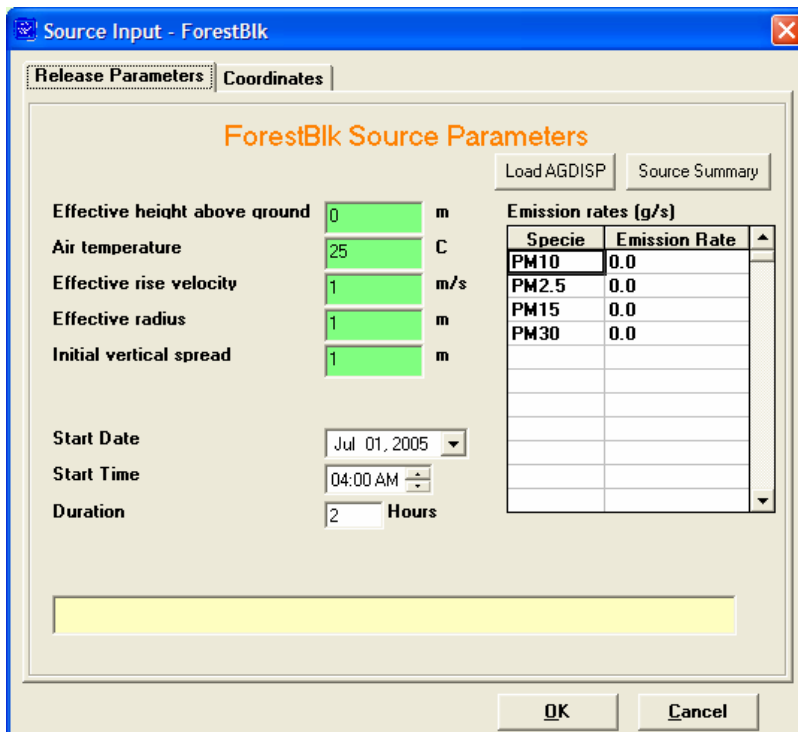


Figure 5.21. Source Input Window

5.1.2.5 Linking SPRAYTRAN to AGDISP Data to Define Area Source Emissions

Data results from AGDISP can be used to define the area source “Emission Rates” on the “Source Input” form (Figure 5.21). To load AGDISP data in SPRAYTRAN, click on the “Load AGDISP” button:

- An information window will be displayed explaining the need to match the meteorological data used in the AGDISP simulation with the meteorological conditions entered for the SPRAYTRAN simulation. This was done in a previous step; click on the “OK” button to close the information window.
- A series of prompts will then appear asking for the name and location of certain AGDISP data files. At each prompt, click “OK” and use the dialog window that appears to select the appropriate AGDISP file. The files used in this example are:
 - Input Summary File: “ExCaseSummaryFile.txt”
 - Vertical Profile File: “ExCaseProfileFile.txt”
 - Deposition Results File: “ExCaseDeposition.txt”
(*Note:* The data in the deposition profile file are not used in SPRAYTRAN’s computations, but are imported to allow for visual comparison between the AGDISP and SPRAYTRAN results)
- Following the selection of the input files, a prompt will be displayed asking for the specie name that will be associated with the calculated emission rate. Enter the name “AGDRIFT” (AGricultural DRIFT) into the prompt window and click the “OK” button. Once the new specie name has been entered, the name will appear in the species list of the area source input window along with the AGDISP-derived emission rate. The new specie name will also be added to the species list on the “Species” tab.
- Click on the “OK” button of the “Source Input” window to close the form.

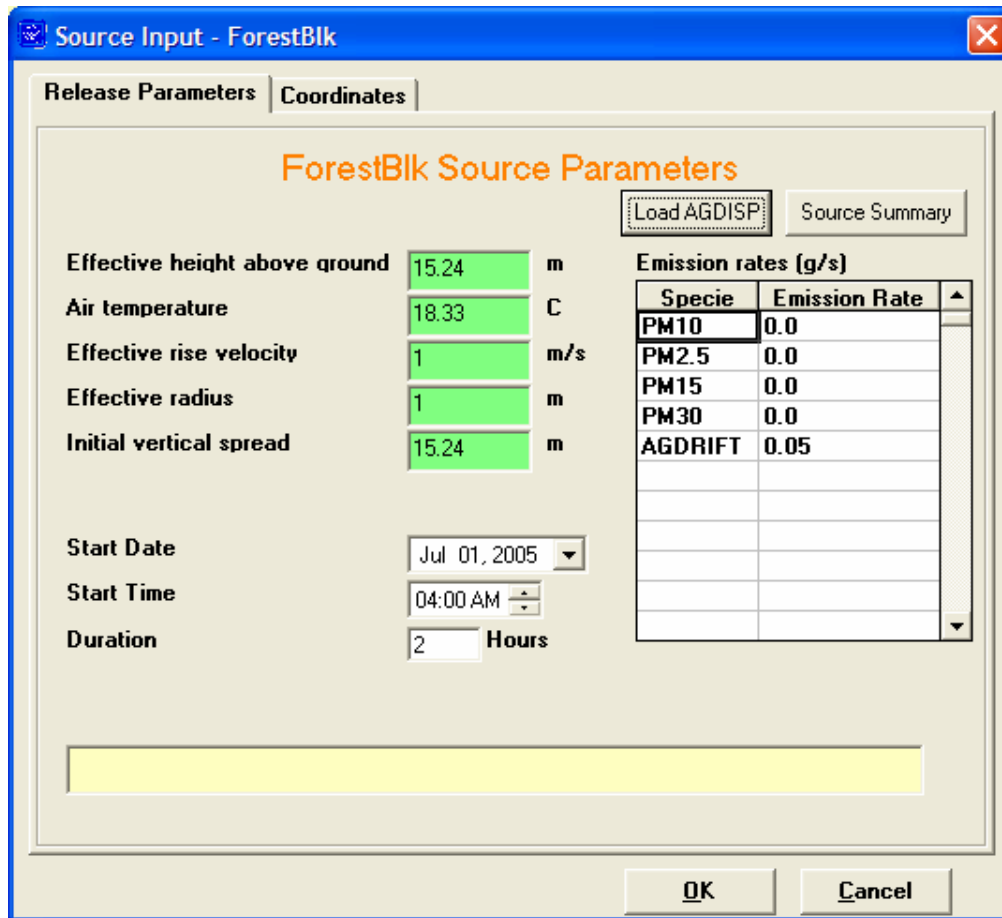


Figure 5.22. Example Case Source Input with Calculated Emission Rate

5.1.2.6 Reviewing SPRAYTRAN Input Parameters

Although the data-entry process is complete, this step explains some special features for checking and verifying certain data-input parameters.

- Species Properties:** Select the “Species” tab in SPRAYTRAN (Figure 5.23). A list of available species will appear, with a check next to the specie name(s) that will be used in the current simulation. Default species (PM10, PM2.5, PM15, and PM30) are listed, but not checked, so they are not be used in the current simulation. “AGDRIFT,” which is a specie associated with the area source “ForestBlk,” is checked and will be modeled in the current simulation. Specie information, such as the mean droplet size, can be reviewed by double-clicking on the specie name. This information was derived and imported from the AGDISP data files associated with a specific source.

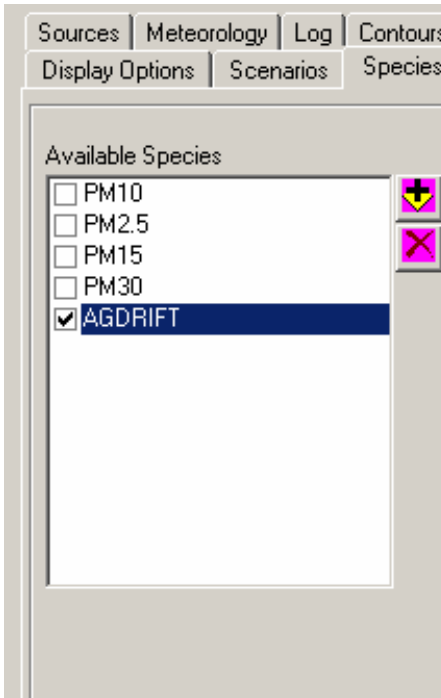


Figure 5.23. Species List

- **Source Characteristics:** To review source characteristics, reload the “Source Input” screen (Figure 5.22) by selecting the “Sources” tab and double-clicking on the “ForestBlk” source name. Click the “Source Summary” button on the “Source Input” window. A summary listing of SPRAYTRAN-interface parameter data will be displayed. These data include size and coordinates of the area source, meteorological data, and flight-plan data. Figure 5.24 shows the source summary for the example case.

Note that the SPRAYTRAN “Wind Direction” and “AGDISP Wind Direction” in this window do not have the same meaning. The “AGDISP Wind Direction” is the direction of the wind relative to the application paths; the SPRAYTRAN “Wind Direction” is the meteorological definition of the direction from which the winds are actually coming.

The summary display also contains a “Flight Path Selection” calculator that can be used to determine the flight-path angle that could be entered into an AGDISP simulation, based upon the wind direction entered on the “Meteorology” tab in SPRAYTRAN. Moving the scroll bar (located beneath the flight-path calculator) to the right results in rotating the displayed flight path in a clockwise manner. As the displayed flight path is rotated, the angle of the flight-path direction and wind direction will be automatically recalculated and displayed in the appropriate text boxes found beneath the flight-path calculator.

To return to the “Release Parameters” for the source, click on the “Source View” button located at the bottom of this form.

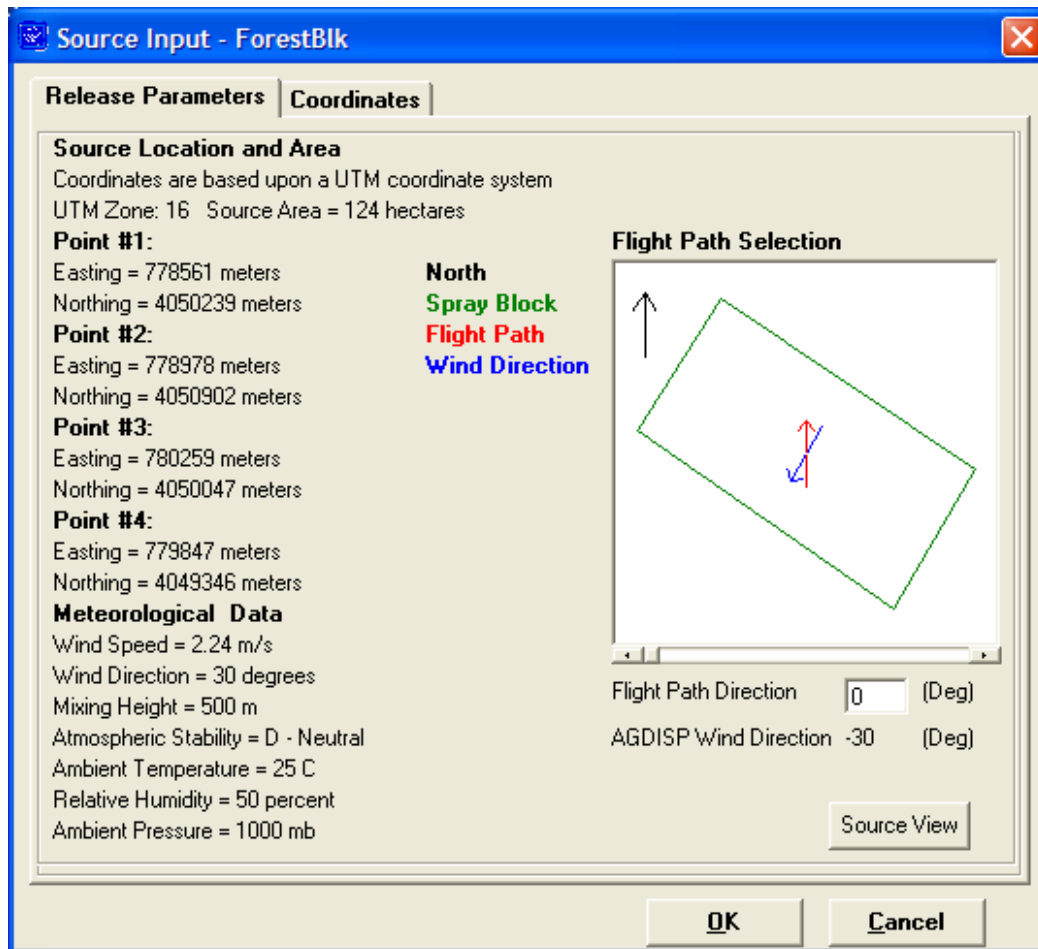


Figure 5.24. Source Input/Source Summary Window

5.1.2.7 Running SPRAYTRAN

To run the example case, click the “Run Simulation” button on the SPRAYTRAN interface. A series of model-run status messages will be displayed near the SPRAYTRAN logo, indicating that a simulation is taking place.

When the SPRAYTRAN simulation is complete, the “Contours” tab can be used to view the model results, including concentration (Conc), exposure (Exp), deposition (Dep), and total deposition (TotalDep). To view the SPRAYTRAN output, select the desired contour from the “Contours Type” list. Figure 5.25 is a display of the SPRAYTRAN-calculated total deposition for the scenario. Results for various time steps can be viewed by selecting the desired “Interval End Time” from the list or using the time navigation buttons to select a time step.

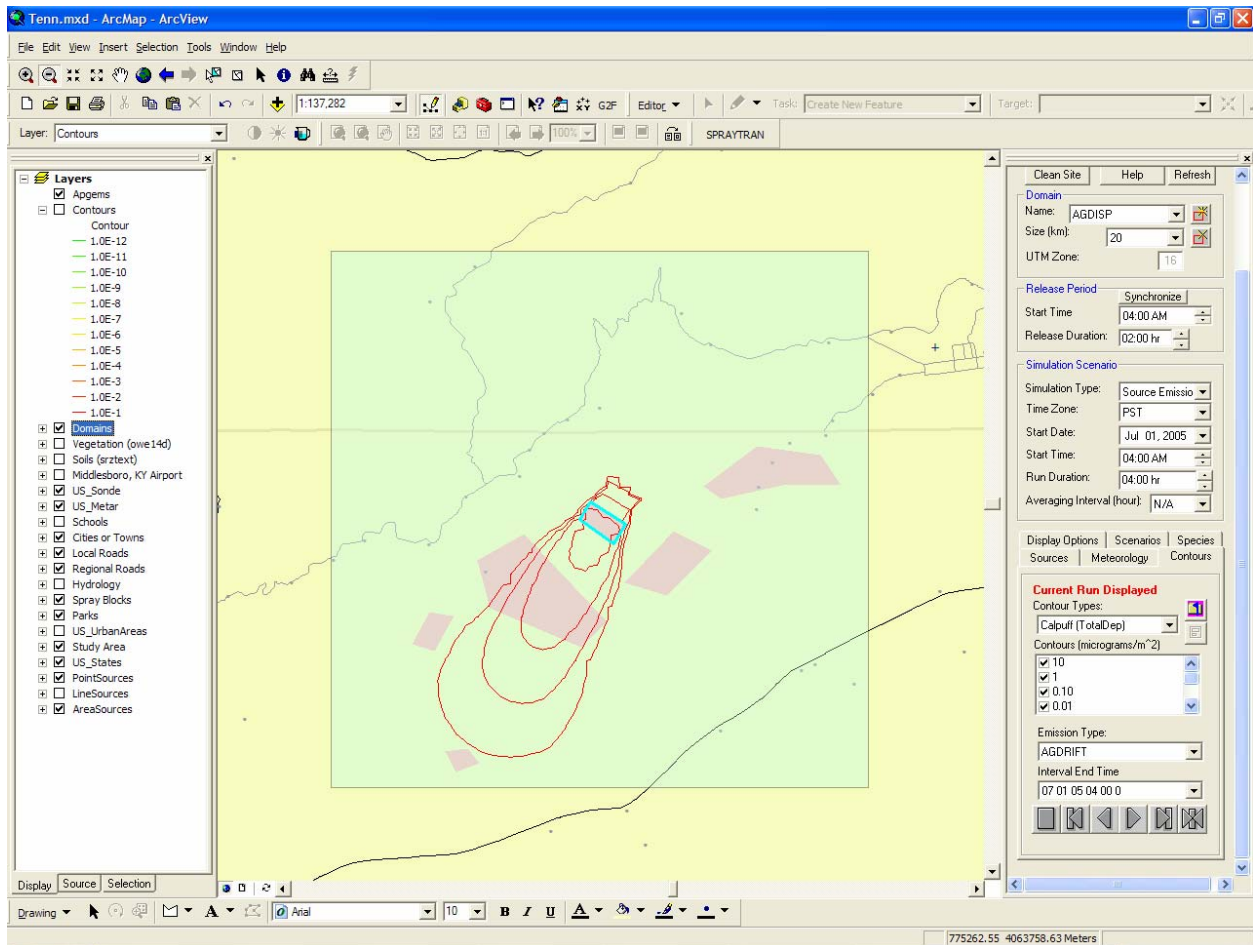
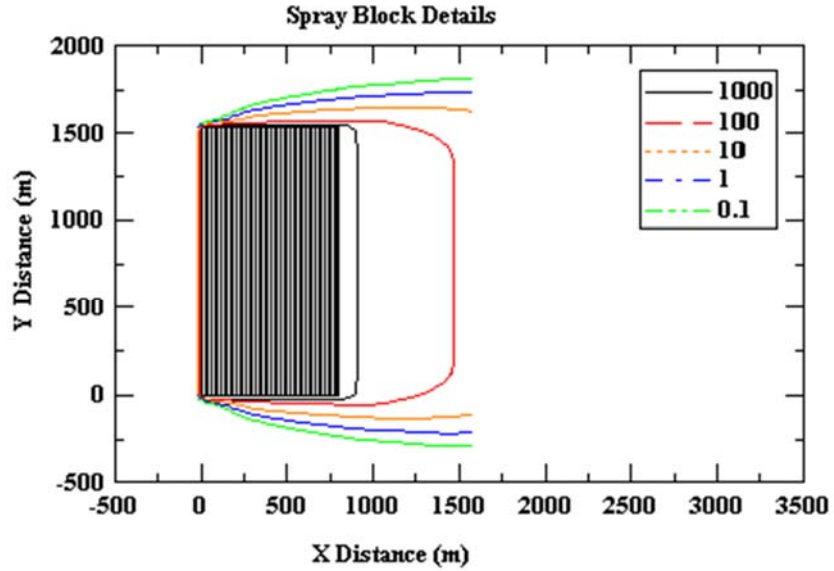


Figure 5.25. Total Deposition for Sample SPRAYTRAN Simulation

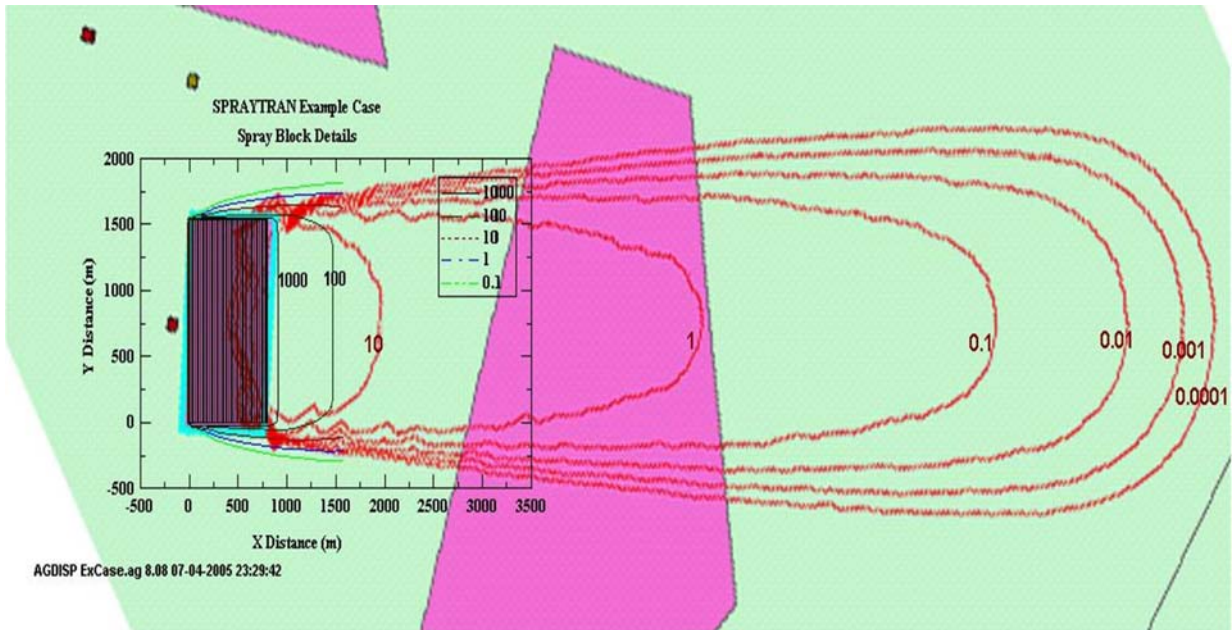
The SPRAYTRAN results shown in Figure 5.25 define deposition patterns at distances of 0.5 km and greater from the spray block. For closer distances, the AGDISP-calculated values should be used. To view near-field AGDISP results in SPRAYTRAN, select “AGDISP (Dep)” from the “Contours Type” and set the “Emission Type” as “CUSTOM.” In this example, the AGDISP-calculated contours (not shown) will be displayed in a different direction because AGDISP makes its calculations based on the relative angles of the wind and application trajectories; the cardinal direction for the deposition is not defined in the AGDISP input files.

To better compare the model results, the deposition plot from AGDISP (Figure 5.26) has been overlaid onto the SPRAYTRAN model result (Figure 5.27). An exact replication of deposition patterns is not expected, although the near-block pattern from AGDISP should be consistent with the down-wind patterns from the SPRAYTRAN dispersion models. AGDISP deposition plots are based on a source term from the spray block for all released material. The SPRAYTRAN deposition plots are based on a source term from the spray block based on the “residual” active chemical mass airborne at 200 m downwind of the spray-block downwind edge. The two models have consistent deposition patterns and magnitudes at transition distances (i.e., downwind distances of several kilometers).



AGDISP ExCase.ag 8.08 07-04-2005 23:29:42

Figure 5.26. AGDISP Near Source Deposition for the Example



AGDISP ExCase.ag 8.08 07-04-2005 23:29:42

Figure 5.27. AGDISP Near-Field Deposition (chart) Overlaid on SPRAYTRAN-Calculated Deposition (red contours)

6.0 References

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Appendix A

Example Data Files for the AGDISP-SPRAYTRAN Linkage

Appendix A: Example Data Files for the AGDISP-SPRAYTRAN Linkage

As described in Section 2, the SPRAYTRAN transport and dispersion modeling system generates source-term parameters from near-field results from the AGDISP model. The method of linking the models is achieved by loading specific output files from an AGDISP simulation into an area source in SPRAYTRAN, which defines the spray block. The specific AGDISP output files used by SPRAYTRAN are:

- Input Data Summary
- Vertical Profile
- Deposition Values.

The first two files—Input Data Summary and Vertical Profile—are used to initialize the area source input parameters in SPRAYTRAN. The “Deposition Values” file is used to generate near-field AGDISP contours for comparison to SPRAYTRAN results within the SPRAYTRAN interface. This section provides a sample for each of the three files and serves as a general reference. The user does not need to be concerned with the actual content of these files, as SPRAYTRAN reads all pertinent information from these files when they are loaded into the interface.

**Table A.1. Contents of the “Input Data Summary File”
(Bold values are read by SPRAYTRAN)**

```
AGDISP Input Data Summary

--General--
Title: SPRAYTRAN Example Case
Notes:

Calculations Done: Yes
Run ID: AGDISP ExCase.ag 8.08 07-04-2005 12:37:21

--Aircraft--
Name                               Air Tractor AT-401
Type                               Library
Boom Height (m)                 30.48
Flight Lines                     44
Optimize Flight Lines              No
Flight Line Reps                    #           Reps
                                     1           1
                                     2           1
                                     3           1
                                     4           1
                                     5           1
                                     6           1
                                     7           1
                                     8           1
                                     9           1
                                     10          1
```

	11	1
	12	1
	13	1
	14	1
	15	1
	16	1
	17	1
	18	1
	19	1
	20	1
	21	1
	22	1
	23	1
	24	1
	25	1
	26	1
	27	1
	28	1
	29	1
	30	1
	31	1
	32	1
	33	1
	34	1
	35	1
	36	1
	37	1
	38	1
	39	1
	40	1
	41	1
	42	1
	43	1
	44	1
Wing Type		Fixed-Wing
Semispan (m)		7.47
Typical Speed (m/s)		53.64
Biplane Separation (m)		0
Weight (kg)		2720.47
Planform Area (m ²)		27.31
Propeller RPM		2000
Propeller Radius (m)		1.37
Engine Vert Distance (m)		-0.3658
Engine Fwd Distance (m)		3.63

--Aerial Application Type--		
Aerial Application Type		Liquid

--Drop Size Distribution--		
Name		ASAE Fine to Medium
Type		Reference
Drop Categories	#	Diam (um) Frac
	1	10.77 0.0010
	2	16.73 0.0003
	3	19.39 0.0007
	4	22.49 0.0003
	5	26.05 0.0007

6	30.21	0.0010
7	35.01	0.0010
8	40.57	0.0020
9	47.03	0.0033
10	54.50	0.0053
11	63.16	0.0067
12	73.23	0.0090
13	84.85	0.0133
14	98.12	0.0223
15	113.71	0.0330
16	131.73	0.0393
17	152.79	0.0480
18	177.84	0.0647
19	205.84	0.0830
20	238.45	0.1147
21	276.48	0.1283
22	320.60	0.1380
23	372.18	0.1127
24	430.74	0.0640
25	498.91	0.0440
26	578.54	0.0317
27	670.72	0.0203
28	777.39	0.0093
29	900.61	0.0010
30	1044.42	0.0007
31	1210.66	0.0003

--Nozzle Distribution--

Boom Length (%)

Nozzle Locations

#	Hor (m)	Ver (m)	Fwd (m)
1	-4.86	0	0
2	-4.62	0	0
3	-4.38	0	0
4	-4.15	0	0
5	-3.91	0	0
6	-3.67	0	0
7	-3.44	0	0
8	-3.2	0	0
9	-2.96	0	0
10	-2.73	0	0
11	-2.49	0	0
12	-2.25	0	0
13	-2.01	0	0
14	-1.78	0	0
15	-1.54	0	0
16	-1.3	0	0
17	-1.07	0	0
18	-0.8295	0	0
19	-0.5925	0	0
20	-0.3555	0	0
21	-0.1185	0	0
22	0.1185	0	0
23	0.3555	0	0
24	0.5925	0	0
25	0.8295	0	0
26	1.07	0	0
27	1.3	0	0

28	1.54	0	0
29	1.78	0	0
30	2.01	0	0
31	2.25	0	0
32	2.49	0	0
33	2.73	0	0
34	2.96	0	0
35	3.2	0	0
36	3.44	0	0
37	3.67	0	0
38	3.91	0	0
39	4.15	0	0
40	4.38	0	0
41	4.62	0	0
42	4.86	0	0

```
--Swath--
-----
Swath Width                               18.29 m
Swath Displacement                         0 m
```

```
--Spray Material--
-----
Name                                       Water
Type                                       Reference
Nonvolatile Fraction                      0.03
Active Fraction                          0.015
Spray Volume Rate (L/ha)                  18.71
Specific Gravity                          1
Evaporation Rate ( $\mu\text{m}^2/\text{deg C}/\text{sec}$ ) 84.76
```

```
--Meteorology--
-----
Wind Speed (m/s)                          2.24
Wind Direction (deg)                       -90
Temperature (deg C)                       18.33
Relative Humidity (%)                       50
```

```
--Atmospheric Stability--
-----
Atmospheric Stability                      Overcast
```

```
--Transport--
-----
Flux Plane Distance (m)                    200
```

```
--Canopy--
-----
Name
Type                                       Height
Height (m)                               21.34
Canopy Roughness (m)                      2.99
Canopy Displacement (m)                   14.94
```

```
--Terrain--
-----
Upslope Angle (deg)                       0
Sideslope Angle (deg)                     0
```

```
--Advanced--
-----
Wind Speed Height (m)                     2
Max Compute Time (sec)                    600
Max Downwind Dist (m)                     200
Vortex Decay Rate (IGE) (m/s)             0.56
Vortex Decay Rate (OGE) (m/s)             0.15
```

Aircraft Drag Coeff	0.1
Propeller Efficiency	0.8
Ambient Pressure (mb)	1013
Save Trajectory Files	No
Half Boom	No

Table A.2. “Numerical Data/Vertical Profiles” File Contents Listing for Different Selections of the AGDISP Flux Plane Distance Parameter. The file listing for the example case is shown as bolded text. The example case parameters used in SPRAYTRAN are shown in italic text.

AGDISP Numerical Data File Contents Listings for Selected Flux Plane Distances				
25 m	100 m	200 m	300 m	399 m
AGDISP Numerical Values	AGDISP Numerical Values	AGDISP Numerical Values	AGDISP Numerical Values	AGDISP Numerical Values
Drop Size Distribution: Vertical Profile Dv0.1 14.64 μm Dv0.5 33.52 μm Dv0.9 123.38 μm Relative Span: 3.24 < 141 μm: 92.68 %	Drop Size Distribution: Vertical Profile Dv0.1 12.12 μm Dv0.5 25.66 μm Dv0.9 44.27 μm Relative Span: 1.25 < 141 μm: 100 %	Drop Size Distribution: Vertical Profile Dv0.1 10.53 μm Dv0.5 22.1 μm Dv0.9 37.92 μm Relative Span: 1.24 < 141 μm: 100 %	Drop Size Distribution: Vertical Profile Dv0.1 9.6 μm Dv0.5 19.81 μm Dv0.9 32.39 μm Relative Span: 1.15 < 141 μm: 100 %	Drop Size Distribution: Vertical Profile Dv0.1 8.98 μm Dv0.5 18.63 μm Dv0.9 29.24 μm Relative Span: 1.09 < 141 μm: 100 %
Accountancy of Active: Application Efficiency: 95.91 % Downwind Deposition: 1.85 % Airborne Drift: 2.24 % Carrier Evaporated: 27.53 %	Accountancy of Active: Application Efficiency: 95.33 % Downwind Deposition: 3.36 % Airborne Drift: 1.31 % Carrier Evaporated: 27.53 %	Accountancy of Active: Application Efficiency: 94.99 % Downwind Deposition: 4.02 % Airborne Drift: 0.9891 % Carrier Evaporated: 27.53 %	Accountancy of Active: Application Efficiency: 94.84 % Downwind Deposition: 4.37 % Airborne Drift: 0.7914 % Carrier Evaporated: 27.53 %	Accountancy of Active: Application Efficiency: 94.72 % Downwind Deposition: 4.61 % Airborne Drift: 0.6728 % Carrier Evaporated: 27.53 %
RunID: AGDISP ExCasenew.ag 8.08 09-01-2005 13:14:44	RunID: AGDISP ExCasenew.ag 8.08 09-01-2005 13:19:39	RunID: AGDISP 8.08 06-23-2005 09:30:31	RunID: AGDISP ExCasenew.ag 8.08 09-01-2005 13:20:46	RunID: AGDISP ExCasenew.ag 8.08 09-01-2005 13:22:41

Table A.3. Deposition Values File

Line Number(s)	File Contents	Data Parameters
1	108 79	Number of x and y points
2 to x*y	<pre> -13.8249 1739.5 0 -13.8249 1721.212 0 -13.8249 1702.924 0 -13.8249 1684.635 0 -13.8249 1666.347 0 -13.8249 1648.059 0 -13.8249 1629.771 0 -13.8249 1611.483 0 -13.8249 1593.194 2.006747E-15 -13.8249 1574.906 1.24907E-12 -13.8249 1556.618 2.062673E-10 -13.8249 1538.33 6.120038E-07 -13.8249 1520.042 2.41917E-06 -13.8249 1501.753 2.425395E-06 -13.8249 1483.465 2.425472E-06 1412.655 -162.4729 8.350052E-08 1412.655 -180.7611 4.204104E-08 1412.655 -199.0493 2.015772E-08 1412.655 -217.3374 9.161351E-09 </pre>	Each line has x coordinate, y coordinate, and deposition value
(a) This example case file has ADISP deposition and coordinate parameters in metric units. The AGDISP metric option must be selected for data transfer to SPRAYTRAN.		

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