

TRIM.FaTE USER'S GUIDE

MODULE 10: COMPILING AND PROCESSING METEOROLOGICAL DATA INPUTS¹

This module provides instructions on how to prepare a meteorological input file for use in TRIM.FaTE. TRIM.FaTE meteorological data processing requires the following two types of meteorological data as inputs for the air advection algorithms in the current TRIM.FaTE library:

- Surface meteorological data; and
- Mixing height data.

Surface data and mixing height data can be obtained from a variety of government and commercial sources. As a first step, the user needs to select appropriate sources of data based on modeling purposes and data availability. The selected data are then processed in two stages. In the first stage, the user processes surface data and mixing height data into a single, specifically formatted meteorological file (i.e., formatted like a meteorological input file for use in ISCST (Industrial Source Complex Model-Short Term) modeling of wet deposition (EPA 1995)). In the second stage, the user processes this formatted file into a meteorological input file for use in TRIM.FaTE. An overview of TRIM.FaTE meteorological data processing procedures is provided in Figure 1.

Specifically, TRIM.FaTE meteorological data processing consists of the following procedures:

1. Specify the requirements for meteorological data (*e.g.*, locations and years of meteorological data);
2. Identify sources available for surface meteorological data and mixing height data;
3. Process surface meteorological data and mixing height data into a single meteorological data input file, using an EPA meteorological pre-processor (i.e., either PCRAMMET or MPRM);
4. Generate the sunrise/sunset file with the latitude/longitude and time zone of the center of the modeled region, using the EPA sunrise/sunset calculation program;
5. Process the PCRAMMET or MPRM output file and the sunrise/sunset file into a single meteorological input file, using the TRIMet meteorological pre-processor; and
6. [optional] Consolidate the hourly meteorological data into larger time steps as needed for a specific TRIM.FaTE run (*e.g.*, two hours, four hours, or longer).

The following subsections discuss in detail the requirements for TRIM.FaTE meteorological data, sources of meteorological input data, and the available meteorological data

¹ Descriptions of library-specific algorithms and properties presented in this module pertain to the July 2005 version of the TRIM.FaTE Public Reference library.

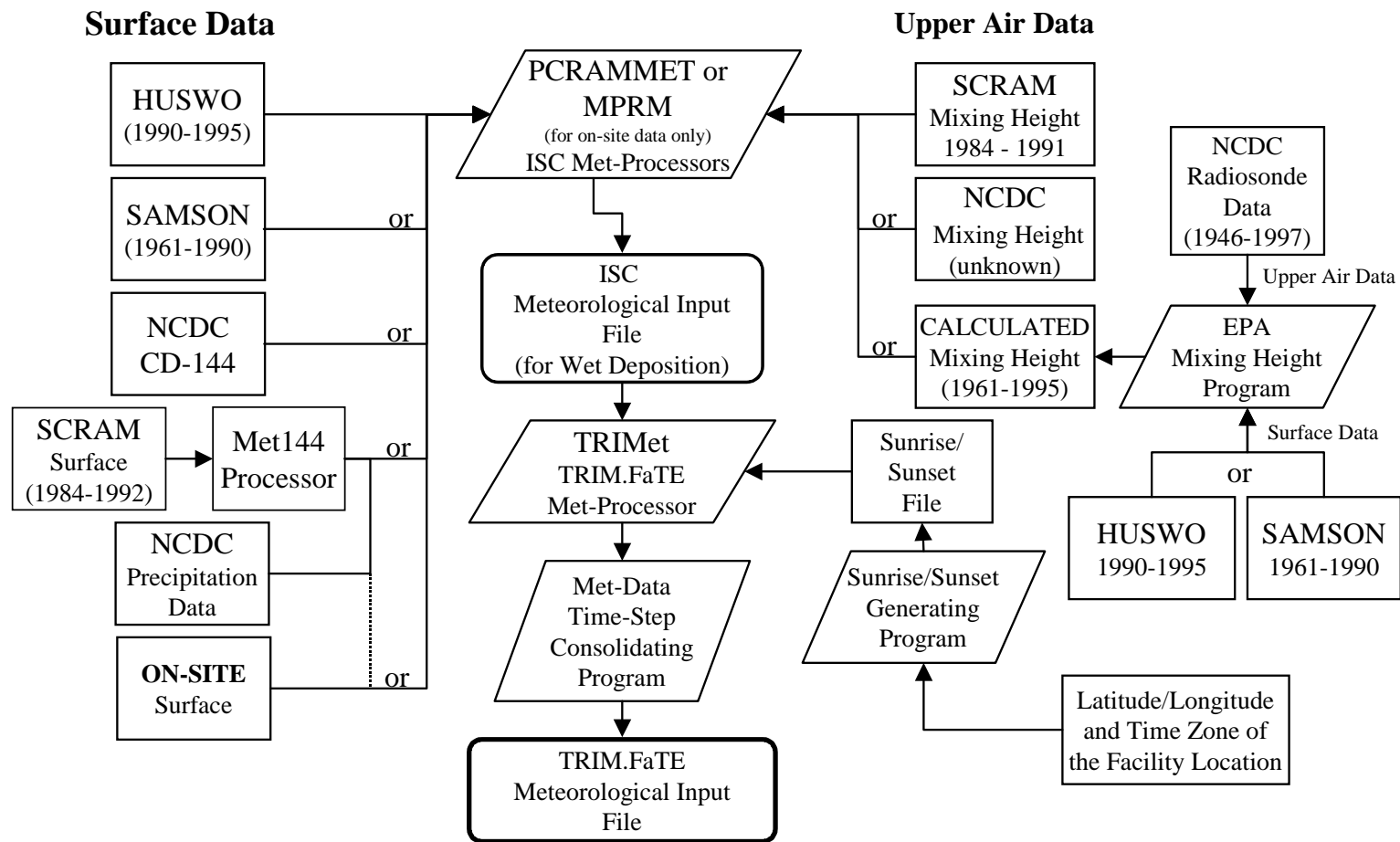


Figure 1. Overview of TRIM.FaTE Meteorological Data Processing Procedures

processing programs. Appendix A provides an example of how meteorological data could be processed for a simple scenario. Appendices B and C, respectively, discuss the minimum wind speed setting and design of the TRIMet processor.

1. REQUIREMENTS FOR METEOROLOGICAL DATA

Algorithms in the current TRIM.FaTE library simulate air transport and deposition of a pollutant released from one or more sources, based on the meteorological data collected at a National Weather Service or local weather station which is geographically and climatically representative of the site to be modeled. The requirements for the meteorological parameters, time steps of meteorological data, and format of the meteorological input file are discussed below.

1.1 Meteorological Parameters

The current version of the TRIM.FaTE library requires the following time and meteorological parameters:

- Date;
- Hour;
- Time zone;
- Horizontal wind speed;
- Wind direction;
- Ambient air temperature;
- Urban or rural mixing height;³
- Precipitation;
- Cumulative precipitation (for each rain event);
- Vertical wind speed; and
- IsDay parameter (used to indicate that the hourly step of simulation is day time or night time).

These parameters can be included in a meteorological input file. These meteorological parameters, and their use in TRIM.FaTE, are described in Table 1.

1.2 Years and Time Steps of Meteorological Data

TRIM.FaTE can be run for any time period, from hours to years, provided appropriate meteorological data are available. The user should determine the appropriate number of years of meteorological data, based on the purpose of modeling. For more information on the time period of meteorological data for air dispersion modeling, refer to the *EPA Guideline on Air Quality Models*, 40 CFR CH 1 Part 51, Appendix W (EPA 2001).

Table 1
Uses of the Meteorological Parameters Required in TRIM.FaTE Modeling

PARAMETER	INPUT UNITS	TRIM.FaTE NAME	DESCRIPTION	USES IN TRIM.FaTE
Horizontal wind speed	m/sec	<i>horizontalWindSpeed</i>	Wind speed in the horizontal direction	Used in determining the horizontal advective flux of a chemical from one air compartment to another.
Wind direction	degrees clockwise from North (representing direction wind is blowing from)	<i>windDirection</i>	Direction from which the wind is blowing	Used in determining the direction of horizontal pollutant air advection. Also used in calculating shear velocity in surface water.
Ambient air temperature	K	<i>AirTemperature_K</i>	Temperature of ambient air	Used in determining the diffusion/volatilization of a chemical between air and surface water compartments. Also used in formulas for estimating several chemical properties.
Mixing height	m	<i>top or bottom</i>	Height of the atmospheric mixing layer (the layer of air directly above the earth's surface that is relatively well mixed)	Used to define the vertical dimensions of the air volume element layer(s); user selects either urban or rural depending on site characteristics.
Precipitation	m/day	<i>Rain</i>	The rate of precipitation	Used in determining the wet deposition of a chemical from air compartments to surface water and soil compartments.
Cumulative rain	m	<i>CumulativeRain</i>	The total precipitation in each rain event. This total is assigned to each hour during the rain event.	Used in calculating the fraction of wet deposition of a chemical from air compartments that is intercepted by leaves.
IsDay parameter	1 or 0	<i>isDay</i>	Indicates whether the met data time step is day time (1) or night time (0).	Used to turn certain biotic processes on or off.
Vertical wind speed ^a	m/sec	<i>verticalWindSpeed</i>	Wind speed in the vertical direction	Used in determining the vertical advective flux of a chemical from one air compartment to another.

^a A value for vertical wind speed must be included as an input for the current advection algorithms in TRIM.FaTE; if vertical advection is not modeled (e.g., if only one layer of air volume elements is included in the scenario) this property can be omitted from the meteorological data file and can be set to zero in the scenario. This module focuses on the data needed to model horizontal advection and does not cover sources or processing of the data needed for vertical advection.

The TRIM.FaTE meteorological input file as processed following this guidance contains hourly values for the meteorological parameters. In some cases, TRIM.FaTE may take a long time to finish a model run when hourly meteorological data are used. To reduce model run time, the user can consolidate the hourly meteorological data into larger time steps, such as two or four hour values. The user should determine the appropriate time step for meteorological data based on model simulation needs and run time considerations as well as defensibility of the time step for the particular application.

1.3 Format of Input File for TRIM.FaTE

TRIM.FaTE can use a meteorological data input file in any delimited text file format. The output file produced by the TRIMet processor, which is suggested for use with TRIM.FaTE, is already in the CSV format. Thus, there is no need to reformat the processed meteorological input file if this method is followed. The CSV format allows the user to open and modify the meteorological input file as a spreadsheet file and save the input file again in the CSV format. Table 2 provides an example of a TRIM.FaTE hourly meteorological input file as it appears when it is opened in a spreadsheet file. Data stored in this input file and referenced by a TRIM.FaTE scenario are used by TRIM.FaTE according to the same conventions that other types of time-varying input files are accessed by TRIM.FaTE (see Module 3 for more information). It is important that the units of meteorological parameters in the TRIM.FaTE meteorological input file always conform with those listed in Table 1. Note that the input file should contain one record for each meteorological data time step that the user wants to model, and the records should be ordered chronologically; however, the time steps do not need to be consistent through the input file. As with any external data file referenced by TRIM.FaTE, the columns do not need to be arranged in the data file in any particular order, and the column headings do not need to follow a specific naming convention.

2. SOURCES OF METEOROLOGICAL DATA

TRIM.FaTE meteorological processing, following the suggested approach described in this module, requires hourly surface meteorological data and twice-daily mixing height data. To maintain consistency with recommendations in the *EPA Guidelines for Air Quality Models* (EPA 1996b), the user should use surface data and mixing height data collected from National Weather Service (NWS) stations or local weather stations.

NWS data can be purchased from the National Climatic Data Center (NCDC) in Asheville, NC, regional climatic centers, and third party vendors. The NWS data are collected from more than 200 weather stations across the nation. The user should select an appropriate station based on proximity to the site of interest and availability of meteorological data. Once the station has been selected, the user can either request the data for selected stations from NCDC or extract the data for that station from NCDC CD-ROM products.

When available, on-site surface meteorological data are generally preferred because these data are geographically more representative of the site to be modeled than data from off-site (and sometimes distant) NWS stations (EPA 1996b). However, on-site data may not contain all the meteorological parameters required for TRIM.FaTE. Therefore, in order to generate a complete meteorological data file, the user may need to obtain NWS data to supplement on-site data.

The mixing height data can be collected as preprocessed data or can be calculated by using the EPA mixing height calculation program. The calculation requires surface and upper air (radiosonde) data. The mixing heights are calculated for each surface station by pairing the surface station with an appropriate upper air station.

In the following subsections, sources of surface meteorological data and mixing height data are discussed. The user should select the appropriate sources of meteorological data based on the needs of the TRIM.FaTE analysis to be performed.

2.1 Surface Meteorological Data

The NWS hourly surface meteorological data can be obtained from the following sources:

- Hourly United States Weather Observations (HUSWO) CD-ROM;
- Solar and Meteorological Surface Observation Network (SAMSON) CD-ROM;
- Surface Observation Data in CD-144 Format; and
- Surface data provided on the EPA SCRAM web page (<http://www.epa.gov/scram001>).

Details on these sources of surface data are provided below.

HUSWO. The Hourly United States Weather Observations (HUSWO) CD-ROM can be purchased from NCDC. It contains surface meteorological data collected between 1990 and 1995 from NWS stations across the nation and contains all of the surface meteorological parameters required for TRIM.FaTE. The CD-ROM has a graphical interface allowing the user to easily extract the data for the NWS station and the years selected by the user. The user should extract the data for all the meteorological parameters for the selected station and years. If the user wants to extract more than one year, the data should be extracted one year at a time. The format of the extracted data files matches the requirements for input to the ISC meteorological processor (i.e., PCRAMMET).

SAMSON. The Solar and Meteorological Surface Observation Network (SAMSON) CD-ROM can also be purchased from NCDC. It contains surface meteorological data collected between 1961 and 1990 from NWS stations across the nation and contains all of the surface meteorological parameters required for TRIM.FaTE. The CD-ROM uses the same graphic interface as the HUSWO CD-ROM, allowing the user to easily extract the data for the selected station and years. The user should extract all of the meteorological parameters available in the CD-ROM. If the user wants to extract more than one year of data, the data should be extracted one year at a time. The format of extracted data files matches the requirements for input to the ISC meteorological processor (i.e., PCRAMMET).

Table 2
Example of Hourly Meteorological Data Input File for Use in TRIM.FaTE

DATE	HOUR	Time Zone	Wind Speed (m/s)	Wind Direction (deg CW from N) ^a	Ambient Temperature (K)	Rural Mixing Height (m)	Urban Mixing Height (m)	Precipitation (m/day)	Cumulative Precipitation (m)	IsDay
1/ 1/1990	0	EST	3.085	231	274.3	1542	1542	0.024	0.002	0
1/ 1/1990	1	EST	4.604	238	275.4	1542	1542	0.012	0.002	0
1/ 1/1990	2	EST	5.096	254	275.9	1542	1542	0.006	0.002	0
1/ 1/1990	3	EST	8.181	273	277	1542	1542	0.006	0.002	0
1/ 1/1990	4	EST	8.806	273	277	1542	1542	0	0	0
1/ 1/1990	5	EST	8.181	292	276.4	1542	1542	0	0	0
1/ 1/1990	6	EST	9.790	295	276.4	1542	1542	0	0	0
1/ 1/1990	7	EST	9.790	283	275.4	1542	1542	0	0	0
1/ 1/1990	8	EST	11.310	267	275.4	1542	1542	0	0	1
1/ 1/1990	9	EST	11.802	281	275.9	1542	1542	0	0	1
1/ 1/1990	10	EST	11.310	284	275.9	1542	1542	0	0	1
1/ 1/1990	11	EST	11.802	276	275.4	1542	1542	0	0	1
1/ 1/1990	12	EST	8.181	283	275.4	1542	1542	0	0	1
1/ 1/1990	13	EST	8.181	289	275.4	1542	1542	0	0	1
1/ 1/1990	14	EST	10.818	292	275.4	1542	1542	0	0	1
1/ 1/1990	15	EST	11.310	284	274.9	1542	1542	0	0	1
1/ 1/1990	16	EST	8.181	291	274.9	1542	1542	0	0	1
1/ 1/1990	17	EST	9.298	327	274.9	1542	1542	0	0	0
1/ 1/1990	18	EST	6.705	284	274.3	1542	1542	0	0	0

a) Value indicates the direction the wind is blowing from as measured in degrees clockwise from north.

CD-144. Hourly surface observation data in CD-144 format for specific years and stations can be requested from the NCDC. This data source does not contain the precipitation data required for TRIM.FaTE modeling. Therefore, the user will need to obtain the precipitation data separately and incorporate it into the meteorological data file. Precipitation data can be requested in TD-3240 format from NCDC. The format of the CD-144 data file matches the requirements for input to PCRAMMET.

EPA SCRAM. EPA provides surface meteorological data collected for the period of 1984 to 1992 from some NWS stations on the EPA SCRAM web page. These data sets have undergone quality assessment checks and are ready for use in regulatory air modeling. The data sets for selected station can be downloaded in zip files directly from the web site (<http://www.epa.gov/ttn/scram/>). However, the SCRAM data sets do not contain the precipitation data required for TRIM.FaTE modeling. Precipitation data can be requested in TD-3240 format from NCDC. In addition, the SCRAM site only includes a subset of the number of stations and years available from NCDC, and at this time EPA does not plan to add any additional data to this site. The formats of both SCRAM data sets and TD-3240 precipitation data sets match the requirements for input to PCRAMMET. Note that the SCRAM surface data will need to be converted to CD144 format using Met144 before inputting it to PCRAMMET.

2.2 Mixing Height Data

Twice-daily mixing height data can be obtained from the following sources:

- EPA SCRAM web site (<http://www.epa.gov/ttn/scram/>); and
- National Climatic Data Center (NCDC), Asheville, NC.

The mixing height can also be calculated by using the EPA Mixing Height Calculation Program. Details on sources of mixing height data and the EPA calculation program are provided below.

EPA SCRAM. The EPA SCRAM web site provides twice-daily mixing height data for the period of 1984 to 1991 collected at 76 NWS Upper Air Observation stations across the nation. The user should select a station that is geographically representative of the site to be modeled. The data sets for each year and station are available in text formats. The user should select the years of data that match the years of surface meteorological data selected for TRIM.FaTE modeling. All the year/station text files available in one state have been compressed into a single zip file. The zip files can be directly downloaded from the EPA SCRAM web page. The SCRAM mixing height data file is ready for input to the PCRAMMET meteorological processor.

NCDC TD-9689. Twice-daily mixing height data in TD-9689 format for specific years and stations can be purchased from the National Climatic Data Center in Asheville, NC. The TD-9689 format matches the requirements for input to the PCRAMMET meteorological processor. The time period for which the data are available is unknown. NCDC should be contacted directly if additional information is desired.

EPA Mixing Height Calculation Program. The EPA SCRAM web site also provides a mixing height calculation program. This program is intended for use when the desired years of mixing height data cannot be obtained from either the EPA SCRAM web site or NCDC sources. The program calculates twice-daily mixing height values based on radiosonde data and surface meteorological data. Radiosonde data for the selected station can be extracted from the Radiosonde Data of North America CD-ROMs, which can be purchased from NCDC. The CD-ROMs contain radiosonde data collected for the period of 1946 to 1997 from the NWS Upper Air Observation stations. The data collected since the most recent CD can be found at <http://raob.fsl.noaa.gov>. The surface data can be extracted from HUSWO and SAMSON CD-ROMs. The mixing height data calculated by this program are similar to, but not the same as, those available on the EPA SCRAM web site and from NCDC. The computer program and user's guide (EPA 1998b) can be downloaded from the EPA SCRAM web site.

2.3 On-site Composite Data

In some cases, on-site data can be obtained by the user directly from local weather stations such as those operated by universities, the military, the Federal Aviation Administration, local and state weather agencies, and other entities. It is expected that on-site data may not always contain all the surface meteorological parameters required for TRIM.FaTE modeling. Therefore, the user may need to obtain NWS surface data from NCDC to supply the data missing in the on-site data sets. The user should use the EPA MPRM meteorological processor (instead of PCRAMMET) to process and incorporate the on-site data sets and NWS data sets into a single meteorological data file. The MPRM processor implements special data quality assessment checks to ensure that the processed meteorological file meets certain requirements for regulatory air modeling.

3. METEOROLOGICAL DATA PRE-PROCESSORS

The following meteorological processing programs can be used to process the meteorological data files for use in TRIM.FaTE applications.

- PCRAMMET – This processor is used to combine the NWS sources of surface data and twice-daily mixing height data into a single meteorological file.
- MPRM – This processor is used to perform a quality assessment of the on-site surface data and combine the on-site data, NWS surface data, and NWS twice-daily mixing height data into a single meteorological file.
- Met144 – This processor is used to convert SCRAM surface data into CD144 format for use with TD3240 precipitation data in PCRAMMET.
- Sunrise/Sunset Calculation Program – This program is used to generate the sunrise/sunset file, which is used for determining the value of IsDay parameter used in TRIM.FaTE.
- TRIMet – This processor is used to process the PCRAMMET or MPRM output file and the sunrise/sunset file into a single meteorological input file for use in TRIM.FaTE modeling.
- TRIM.FaTE Averager – This program is one approach that can be used for the optional step of consolidating hourly meteorological data into longer time steps.

Additional details on the meteorological data processing programs are provided below. Note that what is required to run TRIM.FaTE is a complete and properly formatted meteorological input file (see Table 5 near the end of this section for an example of this format). The user can process the appropriate meteorological data into this format using a variety of tools and approaches. The tools detailed here are suggested to facilitate this process, but they are not the only possible approaches. Appendix A provides a step-by-step example of the creation of a TRIM.FaTE meteorological input file using the tools suggested in this section.

3.1 PCRAMMET

PCRAMMET is a meteorological pre-processor used for preparing NWS data for use in EPA's air quality dispersion models such as ISCST3, SHORTZ, and RAM. The program incorporates surface data and mixing height data into a single meteorological file. The program can be set to one of three Calculation Types (air concentration, dry deposition, or wet deposition) to prepare meteorological input files. For TRIM.FaTE applications, the Calculation Type should always be set to Wet Deposition. The user should refer to the user's guide for detailed information on how to run the PCRAMMET program (EPA 1999). The program and user's guide can be downloaded directly from the web site <http://www.epa.gov/ttn/scram/>.

In the following subsections, basic information on the PCRAMMET input files, required additional meteorological parameters, and output files is provided.

Input Files. PCRAMMET requires the following two or three input files:

- Twice-daily mixing height data;
- Hourly surface meteorological data; and
- Precipitation data (needed only if the surface data do not contain precipitation data).

The input files should contain only one year of meteorological data. The user must make sure that each input file is complete. Information on the appropriate techniques to complete missing data is provided on the SCAM web site. If the user needs to process more than one year of meteorological data, the data should be processed one year at a time. The input files should be placed in the same directory as PCRAMMET.

Additional Meteorological Parameters. PCRAMMET also requires the following meteorological parameters as inputs from the keyboard in the interactive prompt/response session:

- Minimum Monin-Obukhov length;
- Anemometer height;
- Surface roughness height – measurement site;
- Surface roughness height – application site;
- Noon time albedo;
- Bowen ratio;
- Anthropogenic heat flux; and
- Fraction of net radiation adsorbed at the ground.

The user should refer to the PCRAMMET user's guide for guidance on selection of appropriate values for these meteorological parameters.

Output File. The output file from PCRAMMET contains one year of data for the following 17 parameters:

- Year (two digits);
- Month;
- Day;
- Hour;
- Random wind flow vector (i.e., the direction wind is blowing toward);
- Wind speed (m/s);
- Ambient temperature (K);
- Stability category;
- Rural mixing height (m);
- Urban mixing height (m);
- Friction velocity at the application site (m/s);
- Monin-Obukhov length at the application site (m);
- Surface roughness height at the application site (m);
- Precipitation code (or type);
- Precipitation amount (mm);
- Global horizontal radiation (W/m^2); and
- Relative humidity (percent).

The header (or first) record of the output file consists of the following four variables:

- Surface station number;
- Surface station year;
- Mixing height station number; and
- Mixing height station year.

If more than one year of meteorological data are needed for TRIM.FaTE modeling, the user should keep the header record in the first year's output file and remove the header records in the subsequent years' output files. Then the user should use a text editor to combine the output files into a single file. An example of the PCRAMMET output file is provided in Table 3.

Table 3
Example of PCRAMMET Output File

14737	1990	14735	1990										
90 1 1 1	51.0000	3.0845	274.3	4	1542.0	1542.0	0.4378	274.1	0.3000	1	1.02		9999.100
90 1 1 2	58.0000	4.6044	275.4	4	1542.0	1542.0	0.6656	632.3	0.3000	1	0.51		9999.96
90 1 1 3	74.0000	5.0961	275.9	4	1542.0	1542.0	0.7386	779.6	0.3000	1	0.25		9999.93
90 1 1 4	93.0000	8.1806	277.0	4	1542.0	1542.0	1.1948	2348.5	0.3000	0	0.25		9999.76
90 1 1 5	93.0000	8.8064	277.0	4	1542.0	1542.0	1.2871	2938.7	0.3000	0	0.00		9999.73
90 1 1 6	112.0000	8.1806	276.4	4	1542.0	1542.0	1.1948	2353.4	0.3000	0	0.00		9999.70
90 1 1 7	115.0000	9.7899	276.4	4	1542.0	1542.0	1.4321	4054.5	0.3000	0	0.00		9999.57
90 1 1 8	103.0000	9.7899	275.4	4	1542.0	1542.0	1.4321	4058.7	0.3000	0	0.00		9999.57
90 1 1 9	87.0000	11.3098	275.4	4	1542.0	1542.0	1.6588	_999.0	0.3000	0	0.00		9999.52
90 1 110	101.0000	11.8015	275.9	4	1542.0	1542.0	1.7315	_999.0	0.3000	0	0.00		9999.52
90 1 111	104.0000	11.3098	275.9	4	1542.0	1542.0	1.6599	_999.0	0.3000	0	0.00		9999.55
90 1 112	96.0000	11.8015	275.4	4	1542.0	1542.0	1.7318	_999.0	0.3000	1	0.00		9999.57
90 1 113	103.0000	8.1806	275.4	4	1542.0	1542.0	1.2008	_999.0	0.3000	0	0.00		9999.59
90 1 114	109.0000	8.1806	275.4	4	1542.0	1542.0	1.2007	_999.0	0.3000	0	0.00		9999.55
90 1 115	112.0000	10.8181	275.4	4	1542.0	1542.0	1.5863	_999.0	0.3000	0	0.00		9999.55
90 1 116	104.0000	11.3098	274.9	4	1542.0	1542.0	1.6557	6309.2	0.3000	0	0.00		9999.54
90 1 117	111.0000	8.1806	274.9	4	1542.0	1542.0	1.1948	2377.8	0.3000	0	0.00		9999.54
90 1 118	147.0000	9.2982	274.9	4	1542.0	1542.0	1.3597	3513.4	0.3000	0	0.00		9999.52
90 1 119	104.0000	6.7054	274.3	4	1542.0	1542.0	0.9763	1304.2	0.3000	0	0.00		9999.59
90 1 120	107.0000	6.7054	273.8	4	1542.0	1542.0	0.9763	1305.5	0.3000	0	0.00		9999.61
90 1 121	130.0000	8.1806	273.8	4	1542.0	1542.0	1.1948	2392.5	0.3000	0	0.00		9999.54
90 1 122	152.0000	8.1806	273.1	4	1542.0	1542.0	1.1948	2397.3	0.3000	0	0.00		9999.61
90 1 123	100.0000	7.1971	272.5	4	1542.0	1542.0	1.0493	1626.0	0.3000	0	0.00		9999.59
90 1 124	100.0000	6.2137	272.5	4	1542.0	1542.0	0.9031	1038.9	0.3000	0	0.00		9999.56

Note: The "9999" displayed in the second to last column indicates that no value was available for the global horizontal radiation. This parameter is not needed in TRIM.FaTE met processing.

3.2 MPRM

The Meteorological Processor for Regulatory Models (MPRM) is an EPA meteorological pre-processor used to prepare on-site meteorological data for use in regulatory air quality dispersion models. The program can perform data quality assessments of the on-site meteorological data, merge the on-site data with NWS data, and create a meteorological input file for use in a variety of air dispersion models. For TRIM.FaTE applications, MPRM should be used to prepare a meteorological input file for use in ISC modeling of wet deposition. The MPRM program and user's guide can be downloaded from the EPA SCRAM web site at <http://www.epa.gov/ttn/scram/>.

Input Files. MPRM requires the following input files:

- On-site meteorological data;
- NWS surface data (to supplement on-site data); and
- Twice-daily mixing height data.

The user should review the on-site meteorological data to determine which NWS data are needed to supplement the data in the on-site meteorological data file for TRIM.FaTE modeling.

Output File. MPRM allows the user to select the format of output files required for a variety of air dispersion models. For TRIM.FaTE, the user should create an output file that can be used for ISC modeling of wet deposition. If TRIMet will be used as a subsequent processor

(discussed below), the user should ensure that the format of MPRM output files is exactly the same as the PCRAMMET output file format. If more than one year of meteorological data are needed for the TRIM.FaTE run, the user should combine files containing data for individual years (processed separately) into a single file using a text editor.

3.3 Met144

The Met144 program was developed for use with SCRAM format surface data and is available through the SCRAM website under “Meteorological Guidance” (<http://www.epa.gov/scram001/tt24.htm#guidance>). The program performs two functions: 1) checks for missing data in a SCRAM format surface data; and 2) expanding SCRAM format surface data to the NWS CD144 format. The CD144 format is required by the PCRAMMET program, which can be used to process meteorological data into the format required by TRIM.FaTE.

Input File. Met144 requires SCRAM format hourly surface data (unzipped).

Output File. Met144 produces a file with surface data from SCRAM in CD144 format, which can then be used as input to PCRAMMET.

3.4 Sunrise/Sunset Calculation Program

The parameter IsDay is used in TRIM.FaTE to indicate if the hour of a time step is daytime or nighttime. Neither PCRAMMET nor MPRM output files contain this parameter. The IsDay parameter is assigned a value of 1 or 0 (indicating daytime or nighttime, respectively) based on the times of sunrise and sunset in the step of meteorological processing with TRIMet. In TRIMet, IsDay is assigned a value of 1 if sunrise occurs before the hour of a time step or if sunset occurs during or after the hour of the time step. A value of 0 is assigned for all other times. Thus, as one of the meteorological data processing steps, the user needs to calculate the times of sunrise and sunset for each day of the year for the modeling location.

A sunrise/sunset program, named SR-SS, was developed by EPA to calculate the times of sunrise and sunset for each day of the year at any location (latitude/longitude) in the United States. The program is supplied with TRIM.FaTE and is saved in the main TRIM directory during installation with the other TRIM.FaTE application files.

Input Data. The SR-SS program requires the following parameters as inputs:

- Latitude and longitude of the modeling site;
- The time zone of the modeling site; and
- Beginning and ending dates (month and day) of the model run.

Output File. The program will generate an srss.out file that contains the sunrise and sunset times (local standard time) for the days in the user-specified time period of a year. For TRIM.FaTE applications, the user generally should select the time period of 01/01 to 12/31 to cover the entire year. The sunrise and sunset data will be converted to IsDay values in the next step of meteorological data processing with the TRIMet processor.

Running the SR-SS Program. The SR-SS program can be executed by running the SR-SS executable file that was saved with the other TRIM.FaTE application files (e.g., by double-clicking the sr-ss.bat file). A Dos window will appear with prompts for information from the user. As prompted, the user should supply the following information, adhering to the formatting requirements described here:

- Enter the latitude of the modeling site location in degrees using decimal notation (e.g., 40.245).
- Enter the longitude of the modeling site location in degrees using decimal notation (e.g., 74.123). A negative sign does not need to be entered for negative longitudes within the U.S.
- Enter the time zone of the modeling site location using one of the following one-letter codes: E (Eastern), C (Central), M (Mountain), or P (Pacific). Lower-case or capital letters can be used.
- Enter the first date for which the output file will contain sunrise/sunset times, in the format [month],[day]. For example, if the output file should start with January 1, the user would enter 1,1. Note that if the simulation will have duration of at least a year, January 1 must be entered.
- Enter the last date for which the output file will contain sunrise/sunset times, in the format [month],[day]. For simulations of at least a year, December 31 (i.e., 12,31) must be entered.

If data are entered in the wrong format, the SR-SS program will shut down and the appropriate srss.out file will not be created; however, no error message will be displayed. After the last date has been entered, the SR-SS program will automatically create the srss.out file within the same directory that the sr-ss.bat executable file is saved. An example of the output file generated by the sunrise/sunset calculation program is presented in Table 4.

Table 4
Example of Sunrise/Sunset Output File

Julian Day= 001	Sunrise= 7.49	Sunset= 16.54
Julian Day= 002	Sunrise= 7.49	Sunset= 16.55
Julian Day= 003	Sunrise= 7.49	Sunset= 16.57
Julian Day= 004	Sunrise= 7.49	Sunset= 16.58
Julian Day= 005	Sunrise= 7.49	Sunset= 16.60
Julian Day= 006	Sunrise= 7.49	Sunset= 16.61
Julian Day= 007	Sunrise= 7.49	Sunset= 16.63
Julian Day= 008	Sunrise= 7.48	Sunset= 16.64
Julian Day= 009	Sunrise= 7.48	Sunset= 16.66
Julian Day= 010	Sunrise= 7.48	Sunset= 16.68
Julian Day= 011	Sunrise= 7.47	Sunset= 16.69
Julian Day= 012	Sunrise= 7.47	Sunset= 16.71
Julian Day= 013	Sunrise= 7.46	Sunset= 16.73
Julian Day= 014	Sunrise= 7.46	Sunset= 16.75

3.5 TRIMet Meteorological Processor

TRIMet is the meteorological processor developed to process the PCRAMMET or MPRM output file and the sunrise/sunset file (i.e., the srss.out file from the SR-SS program) into a single meteorological input file ready for use in TRIM.FaTE. This program is supplied with the TRIM.FaTE installation. The program implements the following data processing mechanisms:

- Format of the hour – Converts the format of hour from 1 to 24 to 0 to 23;
- Wind direction – Converts the wind vectors (the direction the wind is moving toward) to wind directions (the direction the wind is blowing from) by adding or subtracting 180 degrees;
- Horizontal wind speed – Sets the horizontal wind speed to a minimum value of 0.75 m/sec if the reported wind speed is less than 0.75 m/sec (the justification for this minimum wind speed is provided in Appendix B);
- Precipitation amount – Converts the units from mm/hour to m/day;
- Cumulative precipitation – Calculates the total amount of precipitation (in meters) in each rain event and assigns that amount to each hour during the rain event;
- Hourly mixing height – Sets the mixing height to a minimum value of 20 m; and
- IsDay – Determines the day/night classification (day = 1, night = 0) for each hourly time step based on the sunrise and sunset times in the srss.out file.

If the user believes different minimums are appropriate for horizontal wind speed and mixing height for a particular analysis, those adjustments can be made in the TRIMet code or directly to the TRIMet output file before it is used in TRIM.FaTE. The details of the data processing mechanisms are provided in Appendix C.

Input Files. TRIMet requires the following files as inputs:

- PCRAMMET or MPRM ASCII output file for one year, or a consolidated output file containing data for multiple years; and
- The sunrise/sunset file containing the sunrise and sunset values for each day of a year.

Output File. TRIMet will generate an output file in CSV format (i.e., comma delimited). The user should open the output file using a spreadsheet program to ensure that the output file (1) contains the meteorological parameters required for use in TRIM.FaTE, and (2) covers the desired time period (e.g., one year, five years). The TRIMet output file is ready for input to TRIM.FaTE (see Table 2 for the format of the TRIMet output file when opened in a spreadsheet). Table 5 provides an example of the CSV format of the TRIMet output file.

Table 5
Excerpt of Example CSV Output File Generated by the TRIMet Processor

1/ 3/1989,	6,EST,	1.5433,	106.0000,	270.9,	371.6,	371.6,0.00000,	0.00000,	0
1/ 3/1989,	7,EST,	2.5722,	89.0000,	271.5,	390.8,	390.8,0.00000,	0.00000,	0
1/ 3/1989,	8,EST,	3.0866,	98.0000,	271.5,	410.0,	410.0,0.00000,	0.00000,	1
1/ 3/1989,	9,EST,	3.0866,	134.0000,	272.0,	429.2,	429.2,0.00000,	0.00000,	1
1/ 3/1989,	10,EST,	2.0578,	162.0000,	272.6,	448.4,	448.4,0.00000,	0.00000,	1
1/ 3/1989,	11,EST,	2.5722,	188.0000,	272.6,	467.6,	467.6,0.01224,	0.00126,	1
1/ 3/1989,	12,EST,	1.5433,	181.0000,	272.6,	486.8,	486.8,0.00600,	0.00126,	1
1/ 3/1989,	13,EST,	4.1155,	222.0000,	273.1,	506.0,	506.0,0.00600,	0.00126,	1
1/ 3/1989,	14,EST,	4.6300,	237.0000,	273.7,	506.0,	506.0,0.00600,	0.00126,	1
1/ 3/1989,	15,EST,	4.6300,	290.0000,	274.3,	506.0,	506.0,0.00000,	0.00000,	1
1/ 3/1989,	16,EST,	10.2888,	299.0000,	274.3,	506.0,	506.0,0.00600,	0.00025,	1
1/ 3/1989,	17,EST,	7.7166,	301.0000,	273.7,	521.2,	521.2,0.00000,	0.00000,	1
1/ 3/1989,	18,EST,	7.2022,	307.0000,	273.1,	540.4,	540.4,0.00000,	0.00000,	0
1/ 3/1989,	19,EST,	7.2022,	308.0000,	273.1,	559.6,	559.6,0.00000,	0.00000,	0
1/ 3/1989,	20,EST,	7.2022,	307.0000,	272.6,	578.9,	578.9,0.00600,	0.00025,	0
1/ 3/1989,	21,EST,	7.2022,	309.0000,	272.0,	598.1,	598.1,0.00000,	0.00000,	0
1/ 3/1989,	22,EST,	6.1733,	321.0000,	271.5,	617.4,	617.4,0.00000,	0.00000,	0
1/ 3/1989,	23,EST,	7.2022,	327.0000,	270.9,	636.6,	636.6,0.00000,	0.00000,	0
1/ 4/1989,	0,EST,	6.1733,	336.0000,	270.4,	655.7,	655.7,0.00000,	0.00000,	0

Running the TRIMet Program. The following instructions should be followed to process the data to obtain the TRIMet output file:

- (1) If the SR-SS file has not yet been generated, run the SR-SS program with the latitude/longitude and time zone of the modeling location, and a beginning date of 1/1 and an ending date of 12/31.
- (2) Open the output file (srss.out) using Notepad or another text editor.
- (3) The srss.out file contains the sunrise and sunset times for each day of a year. If more than one year of meteorological data are being processed, the user should copy the entire year of sunrise and sunset records and paste them to the end of the file. Repeat this copy/paste procedure until the file contains exactly the same number of days as the PCRAMMET (or MPRM) output file. Note that if one of the years is a leap year, the user should insert one more sunrise and sunset record for 2/29, which can be a duplicate of the 2/28 or 3/1 record.
- (4) Open the PCRAMMET (or MPRM) output file using Notepad or another text editor.
- (5) If the file contains more than one year of data, remove the header file for each year except for the first year.
- (6) Save the file and note the specified file name..
- (7) Run TRIMet by starting the TRIMet executable file or typing TRIMet (followed by ENTER) from a DOS prompt.
- (8) When prompted by TRIMet, specify the name of the file saved in Step (6).
- (9) When prompted by TRIMet, specify the name of the sunrise-sunset (SRSS) file created in Steps 1-3 (i.e., srss.out).
- (10) When prompted by TRIMet, specify the path and file name for the output file to be created by TRIMet (e.g., TRIMet.out).
- (11) After TRIMet finishes running, import the TRIMet output file into a spreadsheet program using comma as the delimiter. Note that the header record will be split

into three rows. The user should copy the second and third rows of column names to the end of the first row and then delete the second and third row. The user should check and remove any empty cells in the first header row to ensure that column names match the data in each column.

- (12) Save the file as a CSV file under a different name.

IMPORTANT USER TIP

In order for TRIM.FaTE to read the finished CSV output file containing meteorology data, NO hard returns should be included at the end of the data file.

3.6 TRIM.FaTE Averager

The Averager supplied with the TRIM.FaTE program files is one approach that can be used if the user decides to average the hourly meteorological data output file generated by TRIMet into larger time steps for the meteorological input file. Arithmetic averages are applicable for all parameters except wind direction, which is calculated as the average of the unit vectors for wind direction. It should be noted that when using the Averager to process meteorological data, the “-echoFirstLine” flag, which is used to specify that the first line of input data should be copied to the output file and that averaging should begin with the second line of input data, **should not** be used. Detailed instructions on how to use this program can be found in Module 14, Simulation Results and Analyses.

Alternative approaches for consolidating hourly data into longer time steps (e.g., various sampling options) may be appropriate depending on the needs of the application.

4. OTHER TOPICS RELATED TO METEOROLOGICAL DATA

4.1 Land Use Classification

The land use classification of “rural” or “urban” for the modeling region is needed (1) in selecting appropriate values for some meteorological parameters during the step of meteorological data processing with PCRAMMET (or MPRM), and (2) in determining whether rural or urban mixing heights and stability classes (as noted earlier, the latter parameter is not used in calculations in the current version of the model) should be used in TRIM.FaTE modeling.

To make an urban/rural determination, the user can use the Auer method as recommended in the *EPA Guideline on Air Quality Models* (EPA 2001). The Auer method can be summarized as follows (see EPA 1998a for details):

1. Draw a circle with a radius of 3 kilometers from the center of emission location on a land use map;
2. Inspect the map and define in broad terms whether the area within the circle is rural or urban, according to Auer’s definition of land use classification (Table 6);

3. Overlay a grid (for example, 1,000 by 1,000 m) on the land use map and then identify each square as rural or urban (Figure 2); and
4. Count the total number of rural squares; if more than 50 percent of the total squares are rural, the area is classified as rural; otherwise, the area is urban.

The user may want to consider using GIS tools and data sets to facilitate this analysis.

Table 6
Auer's Land Use Classifications

Land Uses Classified As Rural	Land Uses Classified As Urban
<ul style="list-style-type: none"> • Residences with grass lawns and trees • Large estates • Metropolitan parks • Golf courses • Agricultural lands • Undeveloped lands (forest lands) • Water surfaces 	<ul style="list-style-type: none"> • Heavy industrial with less than 5 percent of vegetation • Light/moderate industrial with less than 5 percent of vegetation • Commercial with less than 15 percent of vegetation • Dense single or multiple-family residential with less than 30 percent of vegetation • Multi-family, two-story building residential with less than 35 percent of vegetation

(Table adapted from EPA 1998a)

4.2 Wind Roses

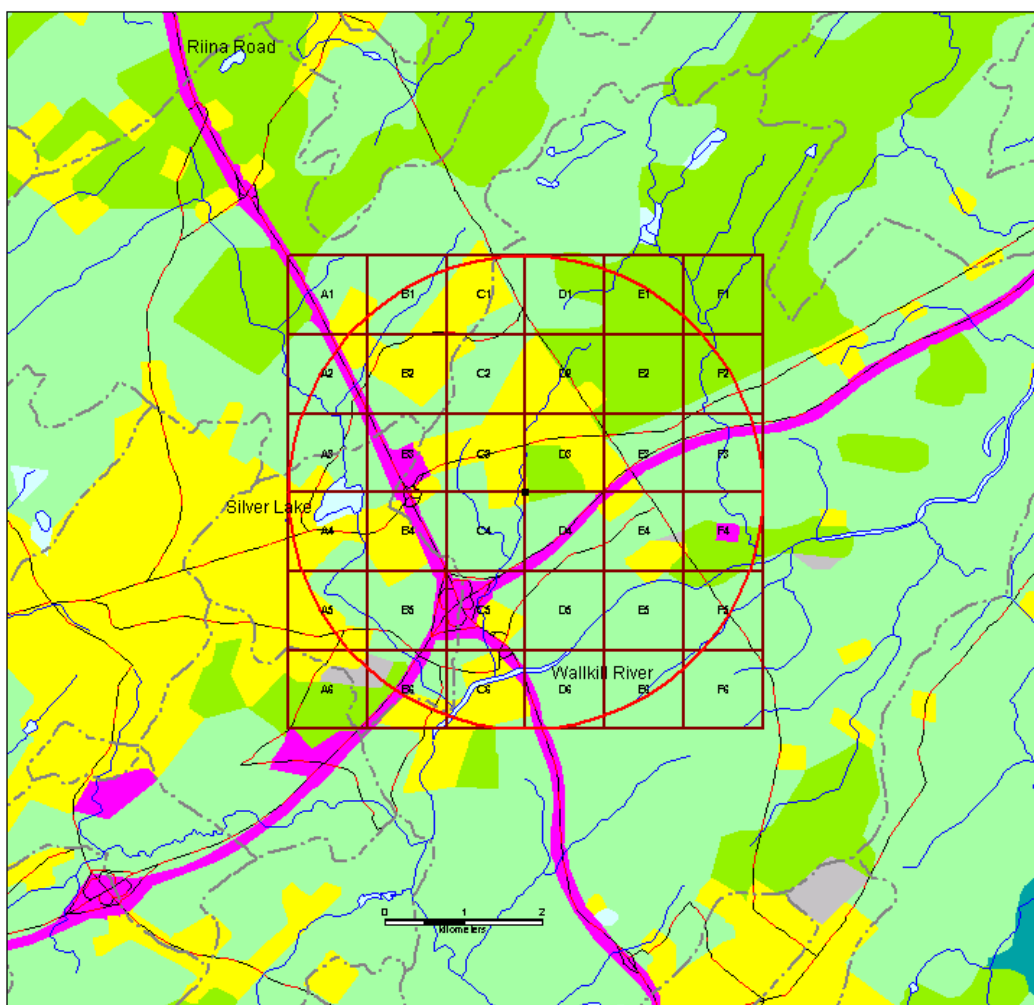
A wind rose can be used to graphically depict the frequency of occurrence of wind direction and speed for a given location and time period. An example of a wind rose is presented in Figure 3 with 16 direction sectors and six wind speed classes shown. Wind roses can be used in some cases to determine the dominant transport direction of the winds for an area. However, due to local terrain, coastal effects, and other factors, the wind rose may not always be representative of wind transport directions. Thus, the wind rose should be used with caution in interpreting the transport direction of pollutant from a specific source. Nevertheless, a wind rose can be a useful visual aid to help in understanding and interpreting TRIM.FaTE modeling results.

A wind rose can be generated using the EPA WRPLOT utility program, which can be downloaded from the EPA SCRAM web site at <http://www.epa.gov/scram001>. The program can use any of the following sources of NWS surface meteorological data as inputs:

- EPA SCRAM Surface Data;
- Surface Data Extracted from the HUSWO CD-ROM; and
- Surface Data Extracted from the SAMSON CD-ROM.

Note that the wind direction included in these sources of surface data are recorded in the “blow from” direction. A wind rose can be developed for either the “blow from” or “blow toward” direction.

Figure 2
Example of a Land Use Map with 1,000 x 1,000 m Grid for
Identifying Land Use Type



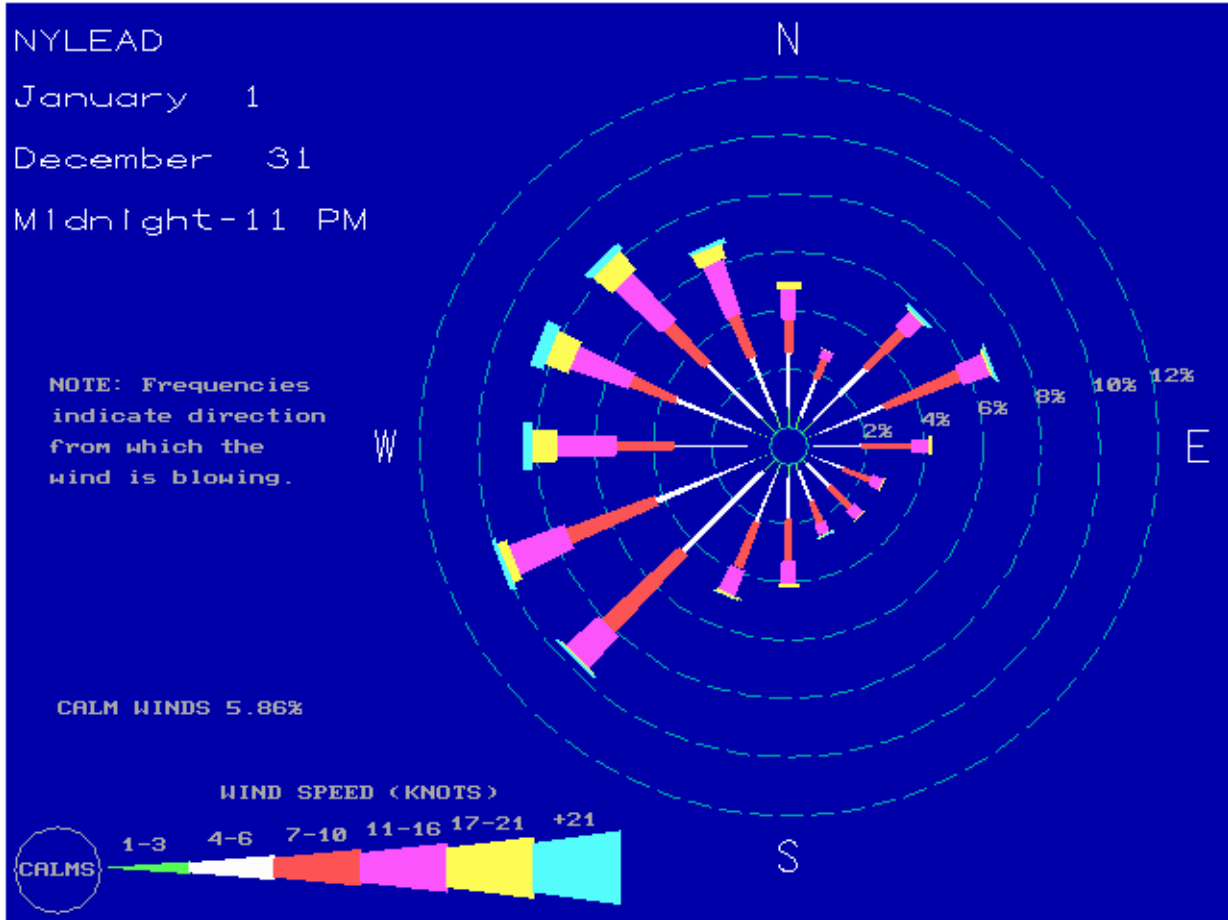
LAND USE	
GRAS	
	Bare/exposed Rock
	Waterbodies
	Mixed commercial/residential
	Agriculture
	Cropland/pasture
	Deciduous
	Evergreen
	Mixed wetland
	Mixed forest
	Rangeland & shrub

Source centered on:
 41 27' 37" N
 74 21' 35" W

10 Km x Km modeling region



Figure 3
Example of a Wind Rose
 (barbs represent the direction wind is blowing from)



5. REFERENCES

U.S. EPA. 2001. U.S. Environmental Protection Agency. Guideline on Air Quality Models. Appendix W to 40 CFR PART 51.

U.S. EPA. 1999. U.S. Environmental Protection Agency. User's Guide to PCRAMMET Meteorological Preprocessor. EPA-454/B-96-001. Office of Air Quality Planning and Standards.

U.S. EPA. 1998a. U.S. Environmental Protection Agency. Human Health Risk Assessment Protocol for Hazard Waste Combustion Facilities. EPA-530/D-98-001A. Volume I. Office of Solid Waste.

U.S. EPA. 1998b. U.S. Environmental Protection Agency. User Instruction – Computing Twice-Daily Mixing Heights From Upper Air Soundings and Hourly Temperature. Office of Air Quality Planning and Standards.

U.S. EPA. 1996a. U.S. Environmental Protection Agency. Analysis of the Effect of ASOS-derived Met Data on Refined Modeling. EPA-454/R-97-014. Office of Air Quality Planning and Standards.

U.S. EPA. 1996b. U.S. Environmental Protection Agency. User's Guide for Meteorological Preprocessor for Regulatory Models. EPA-454/B-96-002. Office of Air Quality Planning and Standards.

U.S. EPA. 1995. U.S. Environmental Protection Agency. User's Guide for the Industrial Source Complex (ISC3) Dispersion Models. EPA-454/B-95-003a,b. Office of Air Quality Planning and Standards.

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APPENDIX A. EXAMPLE OF TRIM.FaTE METEOROLOGICAL INPUT FILE CREATION

This is an example of how to retrieve and process meteorological data inputs for a TRIM.FaTE simulation using data available on CD-ROM from the National Climatic Data Center of the National Weather Service. For this example, we are using data from the Hourly United States Weather Observations 1990 - 1995 (HUSWO), available at:

<http://nndc.noaa.gov/?http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00452-CDR-A0001>

and the Radiosonde Data of North America 1990-1996 dataset (RAOB), available at:

<http://nndc.noaa.gov/?http://ols.nndc.noaa.gov/plolstore/plsql/olstore.prodspecific?prodnum=C00339-CDR-S0001>

To retrieve data from these data sets, the user must enter inputs in response to a number of requests that are prompted upon opening the CD-ROMs. Inputs that are the same for all TRIM.FaTE applications (i.e., any study location) are indicated by text in **bold**. Inputs indicated by text in *italics* are specific to this example, but the inputs required for different applications are likely similar. Also note that all file names should be 8 or fewer characters with no spaces, plus a 3 character extension (XXXXXXXXX.xxx)

1. Specify the requirements for meteorological data

Section 1.1 details the meteorological data requirements for TRIM.FaTE simulations. Data gathered by National Weather Service (NWS) stations typically include all fields required by TRIM.FaTE. As part of defining your TRIM.FaTE simulation, you should choose the site (e.g., city and state) and the years (e.g., 1980-2000) you wish to simulate. This will determine the meteorological data you will need to gather.

For this example, we are modeling a site in Albuquerque, New Mexico, for the period of 1990 through 1993.

2. Identify sources of data and retrieve the files

2.1 Locate appropriate surface and upper air (mixing height) stations. When selecting a station, identify a station that is close to the modeling region and has similar characteristics (e.g., similar elevation, similar location relative to major water bodies).

- First check the HUSWO and RAOB CDs for available nearby stations (this process is described below). If one or more acceptable stations are identified, select the most appropriate one.
- If there are no acceptable stations on the CDs, check for available stations on SCRAM. If one or more acceptable stations are identified, check the NOAA site for hourly precipitation data in TD3240 format from locations near these stations (SCRAM data do not include precipitation data and thus precipitation data must

be found elsewhere to supplement this data set). Use the station locator to identify nearby stations (<http://lwf.ncdc.noaa.gov/oa/climate/stationlocator.html>) and then the station name search to check for data available in TD3240 format (<http://cdo.ncdc.noaa.gov/cgi-bin/cdo/cdostnsearch.pl>). Select the most appropriate combination of SCRAM data and precipitation data from the identified data sets.

Once you have selected a station, note the WBAN number and lat/long of the station for future reference. The remainder of this appendix assumes acceptable data were identified from the HUSWO and RAOB CDs.

We will use Albuquerque, NM, from the HUSWO/RAOB CDs. WBAN # 23050.

2.2 Retrieve (a) surface and (b) upper air data

(a) Insert the HUSWO CD into your computer. Double-click on the HUSWO.BAT file on the HUSWO CD to open the HUSWO software. Follow the instructions below to extract met data (1 year at a time) for the station selected in Step 2.1.

- Click F2 (SelArea). Select “Zoom Box”. Use the tools to center and decrease the size of the box over the state of interest; Press Enter to zoom to box.
- After box is over appropriate area, Press F3 (SelDate).
 - ▶ Select “sequential”
 - ▶ Edit start and end dates to extract 1 year of data (e.g., 01/01/01/90 to 24/12/31/90)
- Press F4 (SelElem)
 - Select “A-Tag all Elements”
- Press F5 (SelStn)
 - Select “W-WBAN #” to pick station
 - Press F3 (Search)
 - Press Tab
 - Type first 4 digits of WBAN # (e.g., 2305)
 - Press F2. Now you can move the cursor up and down in the station list using the arrow keys.
 - Highlight the appropriate station using the arrow keys
 - Press Enter to select the station
 - Press Esc twice to return to the main menu
- Press F6 (Extract)
 - Select “E-Extract Data Records.” Select OK twice.

- Screen will go blank with colored lines. Data will be extracted to C:\HUSWO directory with WBAN # as the name (e.g., *23050.dat*). Press Ctrl-Esc simultaneously to minimize HUSWO program; right-click and select “Close” to close the DOS window.
- Change the name of the results file for identification purposes (e.g., add the year to the end of the file name, such as *23050-90.dat*).
- Repeat this process to extract data for additional years (e.g., *1990-93*).

We now have four surface data files: 23050-90.dat, 23050-91.dat, 23050-92.dat, and 23050-93.dat

- (b) Insert the Radiosonde CD into your computer. Open a DOS window and type the following commands (the exact text you will enter for all applications is in **BOLD**):

```
Q:\> cd C:\
C:\> cd RAOB\raob\
C:\RAOB\raob> getraob D:\RAOBS .
```

Note: if your CD drive is a drive letter other than “D”, replace the “D” in “D:\” in the last line with the correct drive letter for your CD drive.

This will open the Radiosonde software. Follow the instructions in the software to extract data for the years (1 year at a time) corresponding to the years extracted in Step 2.2(a). Select the following options when running the Radiosonde software (the exact text you will enter for all applications is in **BOLD**; basic instructions for what should be entered are in brackets ([]); and the entries for the example data set are in *ITALICS*):

- Enter start date as: [{YR}010100, where {YR} corresponds to the year being extracted] *90010100*
- Enter end date as: [{YR+1}010100, where {YR+1} corresponds to the year after the year being extracted] *91010100*
- GMT sounding hours: **0**
- How do you wish to access the data set? **0**
- What type of station numbers are you using? **1**
- Do you have a file containing this list of stations? **N**
- How many stations for the time period would you like? **1**
- WBAN station number? [Enter station number noted in Step 2.1] *23050*
- What type of output format do you want? **0**
- What type of data levels do you want? **0**
- What type of wind speed units do you want? **0**
- How do you want to organize the output data? **1**
- Where do you want to direct the output? **1**
- Where do you want to write the output files? [Select any location on your hard drive (path only)] *C:\metdata*
- How do you want to structure your output file(s)? **0**

- This is where the data are extracted - wait
- Do you wish to continue accessing this data? **N**
- Would you like to request more data? **Y**

Your file will be saved in the path specified with the start date as the file name (e.g., *C:\metdata\90010100.rao*).

Repeat this process for the remainder of the selected years; the prompt answers should remain the same for each year; only the start and end dates will change. On the final year, the response to “Would you like to request more data?” should be “N.” At the next prompt, type “exit” to quit the program and close the DOS prompt.

We now have four upper air sounding data files: 90010100.rao, 91010100.rao, 92010100.rao, and 93010100.rao.

3. Process the Data

- 3.1. Run the MIXLIB.EXE program for each selected year to generate mixing heights using the data extracted in Step 2.2.

Copy the surface and upper air data files extracted in Step 2.2(a) and (b), respectively, into the same folder as the mixlib.exe program. Double-click on mixlib.exe to run the program. Enter the following, as prompted (the exact text you will enter for all applications is in **BOLD**; basic instructions for what should be entered are in brackets ([]); and the entries for the example data set are in *ITALICS*):

- Enter the name of file of upper air data: [enter the file name] *90010100.rao*
- Enter the name of file of surface obs: [enter the file name] *23050-90.dat*
- Enter the surface obs file type: [enter file type] **HUSWO**
- Enter the output file name: [type a name with no spaces, with 8 or fewer characters] *90mix.txt*
- Enter the year, month and day to start: [enter as YY MM DD] *90 01 01*
- Enter the year, month and day to stop: [enter as YY MM DD] *91 01 01*

Review the output files from MIXLIB.EXE to identify any missing data. Use the methodology provided by EPA (<http://www.epa.gov/scram001/surface/missdata.txt>) to fill in these missing data; you may wish to rename the edited files (e.g., 90mix-r.txt). Once all missing data have been filled in, verify that the files each begin on 12/31 of the preceding year and end on 1/1 of the following year. If either of these dates are missing, duplicate the day just before or just after and change the date (e.g., if 1/1 of the following year is missing, copy the last record, which should be 12/31 of the year of the file, paste it at the end and change the date to 1/1 of the next year). Repeat this process for all selected years.

- **NOTE:** if there are large chunks of data (e.g., more than 2 days) missing from the mixing height file, assess whether sufficient data can still be obtained using this station. If not, consider alternative stations for either upper air or surface data.

We now have four mixing height data files: *90mix-r.txt*, *91mix-r.txt*, *92mix-r.txt* and *93mix-r.txt*.

3.2 Combine the surface and mixing height data into one met file using the PCRAMMET application file. The surface files from the CD and the mixing height files just created (using MIXLIB) must be copied into the same folder as the PCRAMMET program. Run PCRAMMET and enter the following, as prompted (the exact text you will enter for all applications is in **BOLD**; basic instructions for what should be entered are in brackets ([]); and the entries for the example data set are in *ITALICS*):

- Dry or wet deposition calculations: **Wet**
- Enter output filename: [type a name with no spaces, with 8 or fewer characters (if you don't specify a specific directory, it will be saved in the same folder as PCRAMMET)] *90-final.txt*
- Mixing height data filename: [enter the name of the file] *90mix-r.txt*
- Hourly surface data filename: [enter the name of the file] *23050-90.dat*
- Surface data format: **HUSWO**
- Latitude of surface station: [get this from the NWS station list] *35.05*
- Longitude of surface station: [get this from the NWS station list] *106.62*
- Time zone of surface station: [get this from the NWS station list] *7*
- Supplement precip data: **No**
- Monin-Obukhov length: [enter 0 to 150] *50*
- Anemometer height: [from station list] *7*
- Surface roughness length at MEASUREMENT site: *0.4*
- Surface roughness length at APPLICATION site: *0.4*
- Noon-time albedo: *0.5*
- Bowen ratio: *8.0*
- Anthropogenic heat flux: *75*
- Fraction of net radiation absorbed by the ground: *0.22*

Repeat the process for all selected years of data to create a set of combined met files.

Check the output files to ensure that they include complete data for the each year.

We now have 4 surface data files: *90-final.txt*, *91-final.txt*, *92-final.txt* and *93-final.txt*

Put data for all selected years into one file by copying the 2nd year of data and pasting to the end of the first, and repeating this process until all years of data are in a single file.

We now have one file with all surface and mixing height observations: *90-93all.txt*

4. Create a Sunrise/Sunset File

Using the *srss.exe* utility provided with the TRIM installation, create a file of sunrise and sunset times. To run this program, double-click on the *srss.exe* file, and enter the following, as prompted (the exact text you will enter for all applications is in **BOLD** and the entries for the example data set are in *ITALICS*):

- Enter the latitude of the site: *35.05*
- Enter the longitude of the site: *106.62*
- Enter the time zone: *M*
- Enter the beginning date: **01/01**
- Enter the end date: **12/31**

We now have a sunrise/sunset file with one year of data: srss.out. This file will be written into the directory where the srss.exe program is located.

Copy the data and paste them onto the end of the file to create one file with the same number of years of sunrise/sunset data as were processed in the previous steps (in our example, four years).

NOTE: if one of the selected years is a leap year, the user must do the following:

- For 1992, the third year in our example, copy (or average with the next day) the data for Julian day 59 and insert it between Julian days 59 and 60 as day 60. Then, adjust the numbering for days 60 through 365 to be days 61 through 366.

We now have a sunrise/sunset file with 4 years of data: srss4.out

5. Process the Met Data into a TRIM.FaTE Ready Met File Using TRIMet

Run the TRIMet program and enter the following, as prompted:

- Enter the input file name: [enter the file with selected years of surface data] *90-93all.txt*
- Enter the SRSS file name: [enter the sunrise/sunset file] *srss4.out*
- Enter the output file name: [enter the selected file name] *fatemet.txt*

We now have a meteorological data file that can be used in a FaTE simulation: fate_met.txt.

APPENDIX B. TRIMET MINIMUM WIND SPEED

During the development and testing of TRIM.FaTE, it was determined that zero horizontal wind speeds are problematic because whenever the wind speed is zero, there is no advection of chemical mass in air. During the time steps when this occurs, mass in the source compartment builds up quickly as more mass is introduced, and mass in the non-source compartments stays the same until the wind velocity becomes non-zero. This buildup of chemical mass in the source compartment is not generally observed for actual facilities because wind speeds are rarely zero. Measurement devices are only able to measure wind speeds at or above some threshold and any winds below this threshold are recorded as zeroes. This problem was addressed by including a minimum wind speed in the TRIMet processor. As TRIMet processes meteorological data for each time step, it checks if the wind speed is greater than or equal to the minimum wind speed. If it is not, the wind speed for this time step is replaced by the minimum wind speed.

The current minimum wind speed in TRIMet is 0.75 meters per second (m/s). This value was selected by first determining a reasonable estimate of the minimum measurement threshold of anemometers (instruments used to measure wind speed) used for collecting National Weather Service data. This threshold wind speed is effectively the detection limit of the instrument. Based on information provided by EPA (Ted Palma, OAQPS), 1.5 m/s was selected as a reasonable measurement threshold. We then assumed that all wind speeds between zero and 1.5 m/s were uniformly distributed and selected the mean (0.75 m/s) as the minimum wind speed for TRIMet.

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APPENDIX C. TRIMET PROCESSOR

C.1 OVERVIEW OF PROGRAM

TRIMet is the meteorological processor developed to process the PCRAMMET or MPRM output file and the sunrise/sunset file (i.e., the srss.out file from the SR-SS program) into a single meteorological input file ready for use in TRIM.FaTE. This program is supplied with the TRIM.FaTE installation. The program implements the following data processing mechanisms:

- Format of the hour – Converts the format of hour from 1 to 24 to 0 to 23;
- Wind direction – Converts the wind vectors (the direction the wind is moving toward) to wind directions (the direction the wind is blowing from) by adding or subtracting 180 degrees;
- Horizontal wind speed – Sets the horizontal wind speed to a minimum value of 0.75 m/sec if the reported wind speed is less than 0.75 m/sec;
- Precipitation amount – Converts the units from mm/hour to m/day;
- Cumulative precipitation – Calculates the total amount of precipitation (in meters) in each rain event and assigns that amount to each hour during the rain event;
- Hourly mixing height – Sets the mixing height to a minimum value of 20 m; and
- IsDay – Determines the day/night classification (day = 1, night = 0) for each hourly time step based on the sunrise and sunset times in the srss.out file.

The implementation of each of these mechanisms is provided below. Unless otherwise noted, these calculations are performed for each hour in the provided input files.

Format of the hour. TRIMet subtracts one from the hour value in the PCRAMMET or MPRM output files.

Wind direction. If the wind direction in the PCRAMMET or MPRM output file is greater than or equal to 180 degrees, TRIMet subtracts 180. If it is less than 180, TRIMet adds 180.

Horizontal wind speed. If the horizontal wind speed in the PCRAMMET or MPRM output file is less than 0.75 m/s, TRIMet sets it to 0.75 m/s. Otherwise, it uses the value from the PCRAMMET or MPRM output file.

Precipitation amount. Multiplies the precipitation amount in the PCRAMMET or MPRM output file by (24/1,000) to convert from mm/hr to m/day.

Cumulative precipitation. Calculates the total amount of precipitation (in mm) in each rain event from the PCRAMMET or MPRM output file and writes that amount to each hour during the rain event in a temporary file. Divides the total amount of precipitation in each hour by 1,000 to convert from mm to m and writes these hourly values to the output file.

Hourly mixing height. If the rural mixing height in the PCRAMMET or MPRM output file is less than 20 m, TRIMet sets it to 20 m. Otherwise, it uses the rural mixing height value from the

PCRAMMET or MPRM output file. If the urban mixing height in the PCRAMMET or MPRM output file is less than 20 m, TRIMet sets it to 20 m. Otherwise, it uses the urban mixing height value from the PCRAMMET or MPRM output file.

IsDay. Each hour is compared to the sunrise and sunset values from the sunrise/sunset file for the associated day. If the hour is greater than or equal to the sunrise value and less than or equal to the sunset value, IsDay is set to 1. Otherwise, IsDay is set to 0.

C.2 FORTRAN SOURCE CODE FOR TRIMET METEOROLOGICAL PROCESSOR

```
!Created by Mike Huang, ICF, Jan 2003
!Modified by Marsha Fisher, ICF, Feb 2005; June 2005
Program TRIM_MET
  implicit none
  integer:: Year, Month, Day, Hour, StabClass, PT, GHRadio, RHumidity, isDay
  real:: FlowVec, WindSp, Temp, RuralH, UrbanH, FrictionV, Monin, RoughL, PAM, Sunrise, Sunset, WindDir, ptot
  integer:: numrec, ios, i, j, hrs
  character(20)::File1, File2, File3, File4
  logical:: fileexist

!Document the version
write (*,*) "TRIMet Version 2, June 2005"

!get the required file names and open necessary files
write (*,*) 'Enter the Input file name (i.e., ISC format met data file name)'
read (5,2000) File1
write (*,*) 'Enter the SRSS file name'
read (5,2000) File2
write(*,*) 'Enter the Output file name'
read (5,2000) File3
2000 format (A20)
open (10, file=File1, status='old', action='read')
open (11, file = File2, status = 'old', action='read')
inquire(file=File3, exist=fileexist)
IF (fileexist) then
  open (12, file=File3, status='old')
ELSE IF (.not.fileexist) then
  open (12, file = File3, status='new')
END IF
File4 = 'precip.txt'
inquire(file=File4, exist=fileexist)
IF (fileexist) then
  open (13, file=File4, status='old')
ELSE IF (.not.fileexist) then
  open (13, file = File4, status='new')
END IF

numrec = 0
READ (10,*)
DO
  READ (10,*,IOSTAT=ios)
  IF (ios/=0) EXIT
  numrec = numrec + 1
END DO
REWIND(10)
```

```
!calculate cumulative precip and make precip file
```

```
READ (10,*)  
DO i = 1, numrec  
  READ (10,110, end = 70) PAM  
  IF (PAM == 0) then  
    write (13,120) PAM  
  ELSE  
    hrs = 1  
    ptot = PAM  
    DO WHILE (PAM/=0)  
      read (10,110) PAM  
      110 format (T80,F7)  
      if (PAM/=0) then  
        hrs = hrs + 1  
      end if  
      ptot = ptot + PAM  
    END DO  
    DO j = 1, hrs  
      write (13,120) ptot  
    END DO  
    write (13,120) PAM  
    120 format (F6.2)  
  END IF  
END DO
```

```
70 write (*,*) 'Precip file successfully written'
```

```
Rewind (10)  
Rewind (13)
```

```
READ (10,*)  
!write headers in met file  
write (12,*) 'DATE','HOUR','TimeZone','Wind Speed (m/s)', &  
  'Wind Direction (deg CW from N)','Ambient Temp (K)','Rural Mixing Height (m)', &  
  'Urban Mixing Height (m)','Precipitation (m/day)','Cumulative Precipitation (m)','isDay,'  
!read in values  
DO i = 1, numrec  
  read (10,100) Year, Month, Day, Hour, FlowVec, WindSp, Temp, StabClass, RuralH, UrbanH, FrictionV, Monin, RoughL, PT, PAM  
  100 Format (4I2,2F9.4,F6.1,I2,2F7.1,F9.4,F10.1,F8.4,I4,F7.2)  
  read (13,*) ptot
```

```
!convert to 4-digit year, 20XX if less than 40, 19XX if greater than 40  
IF (year < 40) THEN  
  year = year + 2000  
ELSE  
  year = year + 1900  
END IF
```

```
!convert hour to 0-23 and read sunrise/sunset
```

```

hour = hour -1
if (hour == 0) Then
  read(11,101) Sunrise, Sunset
101  Format(T27,F6.2,T42,F6.2)
  SunRise = AINT(SunRise)+1
  SunSet = AINT(SunSet)
  write(*,*) sunrise, sunset
end if

! Convert the wind flowvector to the wind direction (CW from the north)
WindDir = 0
if (FlowVec >=180.0) Then
  WindDir = FlowVec - 180
else if (FlowVec < 180.0) Then
  WindDir = FlowVec + 180
end if

! Convert the windspeed which is less than 0.75 to 0.75 m/s
if (WindSp <0.75) Then
  WindSp = 0.75
end if

! Convert the mixing height to 20 if it is less than 20
if (RuralH < 20) Then
  RuralH = 20
end if

if (UrbanH < 20) Then
  UrbanH = 20
end if

PAM = PAM*24/1000
ptot = ptot/1000

if (hour >= (SunRise) .AND. Hour <=(SunSet)) Then
  Isday = 1
else
  Isday = 0
end if

Write(12, 102)Month,Day,Year,hour,WindSp,WindDir,Temp,RuralH,UrbanH,PAM,ptot,Isday
102  Format(I2,'/',I2,'/',I4,'',I4,'',EST,'',F9.4,'',F9.4,'',F6.1,'',F7.1,'',F7.1,'',F7.5,'',F7.5,'',I2)
End Do

stop

end Program TRIM_MET

```

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