Chapter 7. SMOKE Core Programs

Contents

Overview

Figure 1 shows the SMOKE Core Programs and how they relate to one another. The lines between the files represent one or more files passing between the programs, and as such show

the dependencies among the programs. Unless otherwise noted, the SMOKE programs are applied for area, mobile, and point sources. When a program is only available for one source category, we have added a tag in the figure to show that (e.g., B is used to indicate the biogenic-only programs).

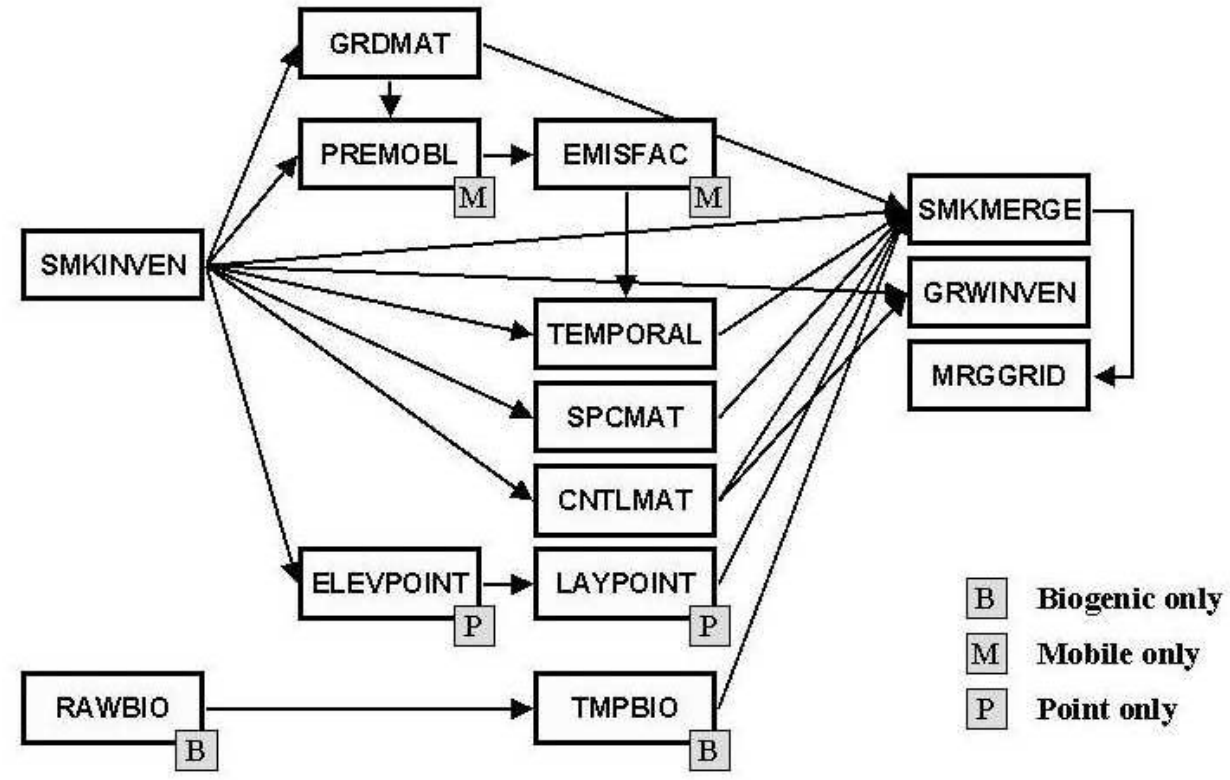

Figure 1: SMOKE Core Programs

The **Smkinven** program, at left in the figure, is responsible for importing the area, mobile, and point source inventory emissions data. For mobile sources, Smkinven can also import activity data in the form of vehicle miles traveled (VMT).

Also at left, the **Rawbio** program is responsible for importing the county or gridded land use data and compute normalized biogenic emissions.

Grdmat creates the gridding matrix for the anthropogenic source categories. For mobile sources, the **Grdmat** program is needed to create an ungridding matrix before **Premobl** and **Emisfac** when temperature dependencies on emission factors are being modeled.

Premobl preprocesses the meteorology data for mobile sources, because the minimum and maximum temperature per day and mobile source are used to compute diurnal emissions.

Emisfac computes both diurnal and non-diurnal emission factors needed when VMT data are used as input for mobile sources. Both **Premobl** and **Emisfac** can be skipped if only emissions data are imported for mobile sources.

The **Temporal** program is used to create an hourly emissions file for the anthropogenic source categories. It can read in day-specific and hour-specific data, and merge this with estimated daily and hourly data created using temporal profiles. For mobile sources, it can compute hourly emissions of CO, NOx, and VOC using the daily VMT, temporal factors (monthly, day-of-week, and hourly), the gridded hourly temperatures, the minimum and maximum temperatures from **Prediur**, and the emission factors from **Emisfac**. If VMT are not used, then the emissions from **Smkinven** are combined with the temporal factors, and the temperature adjustments are not used at all.

Tmpbio applies meteorology adjustments to the gridded, normalized biogenic emissions from **Rawbio**. It also applies the speciation factors needed for the user-selected chemical mechanism and creates gridded, hourly, model-species biogenic emission files for use in Smkmerge or Mrggrid. Rawbio and Tmpbio programs together are the equivalent of SMOKE-Biogenic Emissions Inventory System version 2 (SMOKE-BEIS2).

Normbeis3 creates normalized biogenic emissions from landuse and biogenic emissions factors. **Beis3** applies meteorology adjustments to the normalized emissions created by Normbeis3**.** Beis3 also applies the speciation profiles needed for the user-selected chemical mechanism to create gridded, hourly, model-ready biogenic emissions data. These data can also be used in Smkmerge and Mrggrid. Normbeis3 and Beis3 programs together are the equivalent of SMOKE-Biogenic Emissions Inventory System version 3(SMOKE-BEIS3) prototype. It is important to note that this SMOKE-BEIS3 is a prototype model.

Spcmat creates the speciation matrices (both mass and molar) for the anthropogenic source categories. It uses the user-selected chemical mechanism.

Cntlmat creates the projection matrices, multiplicative control matrices, and reactivity control matrices for the anthropogenic source categories. This program is optional for base-year emissions without controls.

Elevpoint preprocesses the selected plume-in-grid and major point sources. **Elevpoint** is optional if no plume-in-grid or major point sources need to be defined. SMOKE can create elevated emissions for all point sources, so there is no need to specifically indicate the major point sources.

Laypoint optionally computes the plume rise for all point sources based on the meterology.

Smkmerge is used to combine all emissions and matrices to create the gridded, hourly, model-species emissions needed for an air quality model. It can merge for one or all sources categories, and it can read in the model-ready biogenic emissions to merge with the other source categories.

It can merge the matrices with the inventory data output from **Smkinven** or the hourly emissions from **Temporal**, and it can optionally merge the speciation, gridding, or control matrices, or any combination. It also writes state and county totals.

Grwinven is used to grow the emissions to future years using the projection matrix and the imported inventory data from **Smkinven**. It writes both SMOKE inventory format (I/O API NetCDF) and the Inventory Data Analyzer (IDA) format.

Mrggrid is used to combine gridded emission data files, which can be speciated or non-speciated, hourly or time-independent. It can combine a 3-d point source file with any number of 2-d files from other source categories. This program is optional.

BEIS3

Description

Source type: biogenic

This version of BEIS3 is EPA's version BEISv3.09. EPA has not yet (dated April 2002) sanctioned the BEISv3.09 modeling system for use in regulatory applications. BEIS3 reads the gridded, normalized emissions file B3GRD and meteorological data either from MET_FILE1 and/or MET_FILE2 (MET_CRO_2D or MET_CRO_3D). Note that BEIS3 uses surface pressure data that must be in MET_FILE1. Speciation profiles are used to speciate biogenic pollutants into appropriate chemical mechanisms. The speciation profiles used in SMOKE-BEIS3 are much different than those used in SMOKE-BEIS2 modeling. Speciation profiles for the CB-IV, RADM2 and SAPRC99 mechanisms are available for BEIS3 modeling. However, only the CB-IV mechanism has been tested. The normalized emissions and meteorological data are used to produce gridded, speciated, hourly biogenic emissions. Additionally, an optional seasonal switch file, BIOSEASON, can be used to determine when and where to use summer or winter normalized emissions data on a daily basis.

Processing Order

Execute Normbeis3 before Beis3.

If using the seasonal switch option, the seasonal switch file must be created using Metscan.

Beis3 must be executed before using biogenic emissions in Smkmerge.

Input Files

File Name	Description
B3GRD	gridded, normalized biogenic emissions in I/O API netCDF format, from Normbeis3
GRID_CRO_2D	meteorology file in I/O API net CDF format; contains latitude and longitude coordinates for each grid cell
GSPRO	Speciation profiles file **(do not use same profiles used in SMOKE-BEIS2; use profile named 'BV309')** (ASCII)

MET_FILE1	meteorology file in I/O API net CDF format; contains temperature and surface pressure data and possibly radiation/cloud data as well (see BIOMET_SAME environment variable)
MET_FILE2	meteorology file in I/O API net CDF format; contains radiation/cloud data if not in MET_FILE1 (optional)
BIOSEASON	Gridded seasonal switch file in I/O API netCDF; contains daily data with 0 meaning use winter normalized emissions and 1 meaning use the summer normalized emissions, from Metscan (optional)

Input Environment Variables:

- **BG_CLOUD_TYPE:** [default = 1] specifies which meteorological data to use
    - 1: uses RGND or RSD (solar radiation reaching the ground) from MM5 to calculate PAR
    - No other options supported at this time
- **TMPR_VAR:** [default: TA] specifies variable name for temperature to extract from MET_FILE1
- **BIOMET_SAME:** [default: FALSE] indicates whether or not the radiation/cloud data is in same file as the temperature data, MET_FILE1 or a different file, MET_FILE2
- **RAD_VAR:** [default: RGRND] specifies variable name for radiation/cloud data to extract from either MET_FILE1 or optional MET_FILE2
- **BIOG_SPRO:** [default: 'BV309'] specifies the speciation profile for biogenic emissions from GSPRO. See sample BEIS3 script in SMOKE release in $SCRIPTS/run directory.
- **BIOSW_YN:** [default: TRUE] indicates whether or not the user wants to input a gridded seasonal switch file
- **OUTZONE:** see Chapter 5, section on Shared Environment Variables

Output Files

- **B3GTS_L:** (I/O API netCDF) gridded, speciated, hourly biogenic emissions; units in moles/hr

- **B3GTS_S:** (I/O API netCDF) gridded, speciated, hourly biogenic emissions; units in tons/hr
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

This is the first release of a BEIS3 prototype within the SMOKE modeling system. EPA has not yet (dated April 2002) sanctioned the use of BEIS3 for regulatory applications.

CNTLMAT

Description

Source types: area, mobile, point

The Cntlmat program uses control packets to create a projection matrix, and/or a multiplicative control matrix, and/or a reactivity control matrix. The projection matrix contains future year projection factors for all sources. The multiplicative control matrix contains the combination of various types of controls typically used in emissions processing: CTG, MACT, RACT, control efficiency, rule effectiveness, rule penetration, allowable emissions, and caps. The reactivity matrix contains the information needed for applying reactivity controls.

Control Packets. The Cntlmat programs has available entirely different control packets then were available in the SMOKE prototype or EPS2.0. These are described in the section on the GCNTL input file in Chapter 9: SMOKE Files.

Multiple year to year projections. The PROJECTION packet contains the years for which the projection factors apply. There is a "to year" and a "from year". Using a series of these packets, inventory records from different inventory years can be projected to a single modeling year. Cntlmat supports multiple year projections for area, mobile, and point sources.

Reactivity Controls. The program also supports reactivity controls, which are described in Chapter 2 on SMOKE concepts.

Multiplicative Matrix Logic: The multiplicative matrix is built from entries in the /CTG/, /CONTROL/ or /EMS_CONTROL/, and /ALLOWABLE/ packets. The entries in the /CONTROL/ or /EMS CONTROL/ packets are processed first. Either of these packets can be used, but not both. Then the controls from the /CTG/ packet are applied, starting with emissions resulting from the /CONTROL/ or /EMS CONTROL/ packet. Finally, controls from the /ALLOWABLE/ packet are applied, starting with emissions resulting from application of the other packets.

The /CONTROL/ packet is applied using the following logic. Before Cntlmat applies the control efficiency, rule effectiveness, and rule penetration from the packet to the inventory emissions, Cntlmat backs out the existing controls in the inventory, which are provided as part of IDA-formatted inventories. Cntlmat computes the /CONTROL/ packet factor, F, for each source that matches the characteristics of the packet using the following formulas:

$$D = (1.0 - C_{eff} \text{ [inventory]} \times R_{eff} \text{ [inventory]} \times R_{pen} \text{ [inventory]})$$

$B = 1/D$ if $D > 0$
$B = 0$ if $D = 0$

$F = B * (1.0 - C_{eff}$ [packet] x R_{eff} [packet] x R_{pen} [packet])

are used in conjunction with those same data that have been provided in the inventory (and already applied to the emission values). The controls already in the inventory are "backed out" before the controls from the /CONTROL/ or /EMS CONTROL/ packets are applied. For EMS-95 inventories, the controls already applied to the inventory emissions are supplied as part of the the /EMS CONTROL/ packet The following formula is used for this calculation:

The /EMS CONTROL/ packet is processed in a very similar way as the /CONTROL/ packet, with 2 differences. First, the inventory control efficiency, rule effectiveness, and rule penetration values are not provided with the inventory emission input files in EMS-95 format. Instead, these values are provided as part of the control packet values (see the /EMS CONTROL/ packet format). Second, the /EMS CONTROL/ packet contains a "control adjustment factor" field, which overrides all other values in the packet. This override feature which will allow the user to precompute the control factor needed for each record. instead of using the formula listed above for application of the controls.

The /CTG/ packet is processed next, and it uses the following logic. The emission value (after application of /CONTROL/ or /EMS CONTROL/) is compared to the cutoff value specified as part of the /CTG/ packet record. If the emission value exceeds the cutoff value, then the control technology factor is applied to the emissions. If the resulting emissions value still exceeds the cutoff value, then a the maximum achievable control technology (MACT) OR the reasonably achievable control technology (RACT) factor is used. If the MACT factor is defined (greater than 0.), then it is used, but if the MACT factor is not defined (less than or equal to zero), then the RACT factor is used. If neither the MACT or RACT are defined, but the emissions are still greater than the cutoff, then the emissions are set to the cutoff value.

Finally, the /ALLOWABLE/ packet is processed. The entries in this packet override the /CONTROL/, /EMS CONTROL/, and /CTG/ packets. The way this packet is applied depends on whether or not the Cap and Replace values in the packet are greater than 0. If the Cap value is defined, Cntlmat compares the inventory emissions value to the Cap value, and sets a control factor. If the Cap and Replace values are defined, this factor is the Replace value divided by the original emissions value. If only the Cap value is defined, the factor is the Cap value divided by the original emissions value. If the Cap value is not defined, then the factor is the Replace value divided by the original emissions value. If neither the Cap or Replace values are defined, the packet entry is invalid.

Reactivity Matrix Logic: The documentation on how the reactivity matrix is applied has not been incorporated into the user manual, but is available as part of the Final Report on the Models-3/SMOKE integration project.

Processing Order

The Smkinven program must be executed before the Cntlmat program.

The Cntlmat program must be executed before the Smkmerge program, but it is an optional program that needs to be run only when controlled emissions are needed for the air quality model.

Input Files

File Name	Source Type	Description
[AREA|MOBL|PNTS]	A, M, P	I/O API netCDF-formatted inventory files produced by Smkinven program
[A|M|P]SRC	A, M, P	ASCII formatted inventory file produced by Smkinven program
GCNTL	A, M, P	control packets file in ASCII format
GSPRO	all	speciation profiles file, optionally needed for reactivity controls

The physical file name of the input file GCNTL file is typically overridden by the environment that is running Cntlmat. For example, when running SMOKE from scripts using the Assigns file, the projection factor inputs are available for as the [A|M|P]PROJ files. So, the script must set GCNTL as APROJ (for area source processing) after the Assigns file has been invoked by the script, but before the Cntlmat program is actually run.

Input Environment Variables

- **CONTROL_REPORT:** [default Y]
  Sets whether the [A|M|P]CREP control report files are output by the program
    - Y: output a control report file

  - N: do not output a control report file

- **CONTROL_TRACKING:** [default N]

  NOT IMPLEMENTED

  Sets whether a tracking file will be used by the program to allow the specific sources to be tracked for reporting in the control report output file.

- **PROJECTION_YR_SPEC:** [default Y]
  Sets whether entries in the projection packet are in year-specific format

  - Y: year-specific format in use
  - N: year-specific format not in use

- **REACTIVITY_POL:** [default VOC]
  Sets the pollutant name to use in computing

- **REPORT_DEFAULTS:** see Chapter 5, section on Shared Environment Variables.

- **SPEC_OUTPUT:** see Chapter 5, section on Shared Environment Variables.

- **SMK_O3SEASON_YN:** see Chapter 5, section on Shared Environment Variables

- **SMK_SOURCE:** see see Chapter 5, section on Shared Environment Variables.

- **TMP_CTL_PATH:** [default: "."]
  Sets the path for writing the temporary files needed when processing the CONTROL packet (from the GCNTL file)

Output Files

- **[A|M|P]PMAT:** (I/O API netCDF) projection matrix
- **[A|M|P]RMAT_L:** (I/O API netCDF) mole-based reactivity matrix
- **[A|M|P]RMAT_S:** (I/O API netCDF) mass-based reactivity matrix
- **[A|M|P]RSUP:** (ASCII) reactivity matrix supplement file
- **[A|M|P]CMAT:** (I/O API netCDF) multiplicative control matrix

- **[A|M|P]CREP:** (ASCII) report of projections and controls applied to inventory. The header on this file is incomplete with the current version of SMOKE. The columns that are output to this file are for each of the source characteristics.
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype used separate programs for each type of source. These programs were CTLAMAT for area sources and CTLPMAT for point sources. A version of the control/projection program was not previously available for mobile sources.

Cntlmat for SMOKE v1.2 did not have an operational reporting capability.

ELEVPOINT

Description

Source types: point

The purpose of the Elevpoint program is to select elevated point sources and to prepare certain input files for special elevated source or plume-in-grid processing. Prior to version 1.4 of SMOKE, Elevpoint used the PSPLIT and PGROUP files output from the SMOKE Tool to identify SMOKE the major point source (MPS) and major elevated point source emissions (MEPSE) records. In version 1.4 of SMOKE and higher, Elevpoint can be used to select the MPSs and MEPSEs with a variety of criteria such as stack parameters, emissions, and analytical plume rise calculations. Please note that MEPSEs are another name for plume-in-grid (PinG) sources. Also, see "Processing Order" below for more information on when Elevpoint can be skipped.

Elevpoint can be used to identify PinG sources based on emission thresholds, highest day-specific emissions rank compared to other sources, analytical plume rise, and/or stack parameters such as height. Elevpoint will flag all sources as either elevated or PinG based on instructions given in an input configuration file, the PELVCONFIG file. Elevpoint also permits grouping of stacks (called "stack groups") at the same facility if the stack parameters are similar, within tolerances specified by the user with the PRLVCONFIG file. For more information on grouping and selecting elevated and PinG sources, refer to the PELVCONFIG file documentation in Chapter 9.

Elevpoint can also be used to initiate the "cutoff" method of plume rise. This is the method traditionally used to prepare input files to the air quality models UAM-IV, UAM-V, REMSAD, and CAMx, which require separate model-ready input file containing emissions for elevated point sources. Below, we refer to this method as the "UAM-style" of emissions processing.

For the cutoff method, the Elevpoint program uses the stack parameters of the point sources and estimates the plume rise for each source using a Briggs analytical solution (but not actual gridded meteorology data). It then records all of the sources that have an estimated plume rise greater than a specified cutoff as defined in the PELVCONFIG file using the "RISE" instruction. In SMOKE using the PELVCONFIG, this cutoff method can be combined with selection of sources based on stack parameters and/or emissions values.

When emissions are used as part of the selection criteria, Elevpoint computes the maximum daily emissions from one or more PTMP files. This file includes changes to average-day or annual emissions from the emission inventory based on temporal allocation factors, day-specific data, and hour-specific data. Elevpoint computes the maximum daily value of any pollutant used as a selection criteria across all of the days that the user inputs. The user has the option of either

providing a list of paths and file names of one or more PTMP files, or of providing a single PTMP file. The "day" that Elevpoint uses to compute each source's maximum depends on the time zone in which the source resides based on the county and the COSTCY file setting for the time zone (the time zone is stored in the PNTS file output from Smkinven).

Elevpoint also creates a report file that contains all SMOKE sources that have been selected as elevated, their source characteristics including stack parameters, emissions values used as a selection criteria, stack group numbers, elevated or PinG status, and which selection criteria were used to assign the status to the source. The report does not include any low-level sources. This report is in semicolon-delimited format for easier reading into a spreadsheet for sorting, review, and making charts.

Also see Chapter 10 for information about changing SMOKE configurations for different air quality models, some of which involve using the Elevpoint program. The Elevpoint program is not needed if the SMK_PING_METHOD and SMK_ELEV_METHOD are both set to 0.

Plume rise calculation. The Briggs solution is documented in the following:

1. Briggs, Gary A., 1971: Some Recent Analyses of Plume Rise Observation pp 1029 - 1032 in *Proceedings of the Second International Clean Air Congress*, edited by H. M. Englun and W. T. Beery. Academic Press, New York.

2. Briggs, Gary A., 1972: Discussion on Chimney Plumes in Neutral and Stable Surroundings. *Atmos. Environ*. 6, 507 - 510. (Jul 72).

The following formula is used in ELEVPOINT:

```
F = 0.25 * G * V * D**2 * (TS - T)/TS
```

For F less than 55,

```
DISTF = 21.31311057 * F**0.75 / U
```

Otherwise,

```
DISTF = 38.87776061 * F**0.6 / U
```

And finally,

```
PLUMERIS = H + DISTF
```

Where,

- D = Stack diameter (m)
- G = Mean gravitational acceleration (9.80665 m/s**2)
- H = Stack height (m)
- T = Stack temperature (deg K)

- TS = Standard temperature (deg K)
- U = Default wind speed (m/s)
- V = Stack exit velocity (m/s**2)

Also, the constants and variables use the following standard parameters:

- Standard temperature = 293 deg K
- Standard pressure = 960 mb
- Default wind speed = 2 m/s
- Pasquill stability KST = 2

The algorithm has been improved from the original so that the discontinuity at F = 55 no longer exists. Now, DISTF approaches 595 as F approaches 55 from either side.

In summary, Elevpoint permits the following combinations of source selection and processing.

- Identify MEPSE/PinG sources for outputting to special PinG files only (all other point sources will be treated as potentially elevated by Laypoint).
- Identify elevated sources (MPSs) with PELVCONFIG file, which might include using the cutoff method alone or in combination with other criteria.
- Identify elevated sources (MPSs) and PinG sources (MEPSEs) with PELVCONFIG file with cutoff method (Laypoint not used) AND identify MEPSE/PinG sources with PSPLIT for outputting to special PinG files.

Processing Order

The Smkinven program must be run for point sources before the Elevpoint program.

If PELVCONFIG file uses emissions as a source-grouping or source-selection criterion, then Temporal must be run before the Elevpoint program.

The Elevpoint program must be run before the Laypoint program.

Elevpoint does not necessary need to be run. It can be skipped if the following criteria are met:

1. A UAM-style model is not being used (e.g., UAM, REMSAD, CAM_X).
2. No MEPSE/PinG source processing is required.

3. The user is willing to run Laypoint for all point sources and treat them as "potentially elevated". Sources that rise above layer 1 will be "elevated" for reporting purposes in Smkreport, but these sources may sometimes be in layer 1 if the plume rise algorithm in Laypoint computes it that way.

Input Files

File Name	Source Type	Description
G_GRIDPATH	A, M. P	contains description of the modeling grid in ASCII format. Needed for SMK_PING_METHOD > 0 and/or SMK_ELEV_METHOD > 0
PNTS	P	point I/O API netCDF inventory file produced by the Smkinven program
PSRC	P	point ASCII formatted inventory file produced by the Smkinven program
PTMPLIST	P	optional point I/O API netCDF hourly inventory file produced by Temporal program; only needed when PELVCONFIG specifies emissions as one of the selection or grouping criteria
PELVCONFIG	P	optional ASCII elevated source configuration file, prepared by users

Input Environment Variables

- **SMK_ELEV_METHOD:** [default 0: (treat all sources as potentially elevated)] Defines the method to use in SMOKE for determining and processing elevated point sources. The setting chosen depends on the model output format needed from SMOKE. All PinG sources determined based on SMK_PING_METHOD will automatically be considered elevated sources (as defined specifically for the model for which you are creating emissions).

    - 0: Treat all sources as potentially elevated, and let the Laypoint program determine which sources are elevated and which are not. This approach is only appropriate for SMOKE output for the CMAQ and MAQSIP models.

    - 1: Use Elevated section of PELVCONFIG configuration file. This approach can be used for any model output format. This method can be used to implement the

"cutoff" method traditionally used for selecting elevated sources for UAM-style emissions processing.

For UAM-style emissions processing, this environment variable *must* be set to 1 and to indicate a PELVCONFIG file will be used to select specific sources. Such processing is needed for UAM, REMSAD, and CAM$_X$. Users may use the PELVCONFIG file to implement the "cutoff" approach traditionally used for UAM-style processing. In rare cases of a very small inventory, it might be acceptable to specify 0 for this setting, provided that the user is sure that the treating all sources as elevated sources in UAM-style models is acceptable. We do not recommend such an approach for typical SMOKE applications for UAM-style models.

Either approach is acceptable for CMAQ and MAQSIP.

- **SMK_ENG2METRIC_YN:** [default: N]
  Defines whether or not the program converts English to metric units. Only affects program behavior when the program reads the PGROUP file (SMK_PING_METHOD = 1)
  - Y: performs unit conversion
  - N: does not perform conversion
- **SMK_PING_METHOD:** see Chapter 5, section on Shared Environment Variables.
- **WEST_HSPHERE:** see Chapter 5, section on Shared Environment Variables. Only affects program behavior when the program reads the PGROUP file (SMK_PING_METHOD = 1).

Output Files

- **PELV:** (ASCII) elevated point source identification file in ASCII format
- **STACK_GROUPS:** (I/O API netCDF) plume-in-grid and/or elevated sources stack parameters file
- **REPPELV:** (ASCII) reports the sources selected as elevated and PinG and other information about the sources including why they were selected
- **LOGFILE:** (ASCII) contains the log generated from executing this program

Earlier Versions

This program is an updated version of the ELEVPOINT program in the SMOKE prototype. The

new version creates the STACK_GROUPS file for use with plume-in-grid models.

Versions after 1.3 also include new capabilities for selecting plume and grid and elevated sources using the PELVCONFIG file. Version 1.3 and earlier used the PSPLIT and PGROUP files, which are no longer supported by Elevpoint. The PSPLIT and PGROUP files were created manually or using the SMOKE Tool in the Models-3 Framework, but SMOKE versions after 1.3 no longer rely on the SMOKE Tool or users to prepare these files. The REPPELV file did not exist in versions 1.3 and earlier.

EMISFAC

Description

Source type: mobile

The Emisfac program drives EPA's Office of Mobile Sources MOBILE model (version 5b) to generate diurnal and non-diurnal emission factors representing several different emission processes. Because Emisfac executes MOBILE for the emissions, very complex combinations of emission factors can be generated in a relatively short period of time. A mobile control strategy is implemented using these combinations of emission factors.

The program drives MOBILE5 by supplying a range of ambient temperatures, combinations of minimum and maximum temperatures, and a scenario-specific MOBILE5 parameter file MPREF. Using multiple calls to MOBILE5, EMISFAC creates a diurnal and nondiurnal emission factors table for the specified temperatures and input parameter combinations.

MOBILE model. Emisfac uses MOBILE5b. Small modifications have been made to both based on the Lake Michigan Ozone Study (LMOS) changes. These changes ensure that the evaporative emission factors no longer have a diurnal component, which permits additive operations on the evaporative emission and the diurnal emissions without double counting. Additional changes allow Emisfac to interface better with MOBILE and to manage the emission factor simulations.

Parameter Scheme Index. An important concept in mobile emissions modeling is the Parameter Scheme Index (PSI). More information on the PSI is available in Chapter 3, Source-Category-Specific Concepts.

Efficiencies. Emisfac has greater efficiency than other methods of mobile emission factor processing. This efficiency is due to the PSI and to temperature data management. Emisfac outputs two files containing emission factors: a diurnal emission factors file (MEFSD) and a nondiurnal emission factors file (MEFSND). The emission factors are stored in these files for each PSI in MPREF, for all vehicle types, and for all temperatures needed for a given run.

The output files from Emisfac are intended to be "master lists" of emission factors, and are used for many different strategy runs. Therefore, one source of improved efficiency is being able to reuse the emission factors in these files for many different runs. Since the MPREF file stores the definitions of all of the emission factors in both the MEFSD and the MEFSND files, there is always a record of what these emission factors represent. When new emission factors need to be added, or existing ones need to be updated, these files may be updated instead of regenerated.

Emisfac can also reduce the number of MOBILE runs by executing MOBILE for only those speeds required in the definitions of the PSIs and for a limited number of temperatures.

Another efficiency is that the tables can be reused. Emisfac is designed to permit the user to add on emission factors to the emission factor tables that it creates. Therefore, if only a few new emission factors need to be added, the whole scenario need not be rerun. This feature is not working in the current version of Emisfac.

Temperatures. The processor has been designed to limit the number of temperatures for which MOBILE must be run. Temperatures are treated differently for diurnal and nondiurnal emission factors. In order to calculate diurnal emission factors, Premobl output is required to supply information on the minimum and maximum temperatures for all days and for each emission factor. For nondiurnal emission factors, Emisfac requires a run-time-specified starting and ending temperature (in degrees F) for which emission factors are to be calculated. It then calculates all EFs on an increment over that interval. The increment and interval are defined by environment variables as described below. The temperatures in the MOBILE inputs in the MPREF file are not used by the MOBILE routines.

Processing Order

The Smkinven, Grdmat, and Premobl programs must be run before the Emisfac program.

The Emisfac program must be run before the Temporal and Smkmerge programs for mobile sources.

The Emisfac program is not needed if activity data are not used in the SMOKE mobile inventory file.

Input Files

File Name	Source Type	Description
MEFSD_IN	Optional, M	input diurnal emission factors file in I/O API netCDF format to use when REUSE_DIURNAL is set to Y
MEFSND_IN	Optional, M	input nondiurnal emission factors file in I/O API netCDF format to use when REUSE_NONDIURNAL is set to Y
MEFTEMP	M	minimum-maximum temperature combinations for each parameter scheme index (PSI) in ASCII format, from Premobl
MEFUPD	Optional, M	input file of PSIs in ASCII format; forces updating, regardless of whether or not the PSIs are already in the MEFSND_IN and/or MEFSD_IN files

MPLIST	M	the emission factor index list is used to cross-reference which emission factors to use for each source for each of 24 hours.
MPREF	M	emission factor input data files (e.g., concatenated MOBILE5 input files)
MCODES	M	mobile codes file in ASCII format; for converting road class numbers and vehicle type numbers to SMOKE internal standard

Input Environment Variables

- **EF_FORCE_UPDATE:**
  Defines whether or not to use the MEFUPD file.
  - Y: use the MEFUPD file
  - N: do not use the MEFUPD file
- **EF_YEAR:** [default: 1988]
  Integer value for the year for which to create emission factors
- **MB_HC_TYPE:** [default: VOC]
  Character value for type of hydrocarbon pollutant to generate from MOBILE5. Valid values are: THC, NMH, VOC, TOG, NMO, and ROG.
- **REUSE_DIURNAL:** [default: N]
  Defines whether to update an existing diurnal emission factors file or create a new one.
  - Y: update existing file
  - N: create new file
- **REUSE_NONDIURNAL:** [default: N]
  Defines whether to update an existing nondiurnal emission factors file or create a new one.
  - Y: update existing file
  - N: create new file
- **SMK_EF_ACTIVITY:** [default: VMT]
  Name of the activity variable for creating emission factors. NOTE: Only the default value may be used in the current version of SMOKE.

- **SMK_EF_MODEL:** [default: MOBILE5]
  Name of the emission factor model to use. NOTE: Only the default value may be used.

Output Files

- **MEFSD:** (I/O API netCDF) diurnal emission factors file
- **MEFSND:** (I/O API netCDF) nondiurnal emission factors file
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

If emissions are available in the MOBL file from the Smkinven program, then the Emisfac program does not need to compute emission factors for those records. Prior versions of SMOKE did not have mobile emissions stored in the MOBL file and required emission factors to be calculated for all mobile source records.

GRDMAT

Description

Source types: area, mobile, point

The purpose of the Grdmat program is to produce the matrix that contains the factors for spatial allocation of the emission sources to the modeling domain.

Point sources are assigned to grid cells using the geographic coordinates that are stored in each point source record. For area and mobile sources, a cross-reference file matches the gridding surrogates to the source-level emissions. Application of the gridding cross-reference files in SMOKE will always be done so that the most-specific matches override the least-specific ones.

In the current version of SMOKE, a gridding surrogates file needs to be created for the specific grid of interest. This can be accomplished in a variety of ways:

- ArcInfo processing by an expert in creating gridding surrogates
- Models-3 SMOKE Tool
- Extracting surrogate data from a larger gridding surrogates file. A number of efforts are underway to create surrogates at 4 kilometer resolution for the entire U.S. To use these data, you must adopt the grid projection used to create the gridding surrogates for your modeling.

For area sources, the available combinations and their order provided by the gridding cross-reference are the following, starting with the most specific.

1. Country/State/County code and 10-digit SCC code
2. Country/State/County code and 7-digit SCC code
3. Country/State code and 10-digit SCC code
4. Country/State code and 7-digit SCC code
5. 10-digit SCC code
6. 7-digit SCC code
7. Country/State/County code
8. Country/State code

9. Ultimate default

For mobile sources, the available combinations and their order are:

1. Country/State/County code, and 10-digit SCC
2. Country/State code and 10-digit SCC
3. Country/State/County code
4. Country/State code
5. 10-digit SCC
6. Ultimate default

For mobile sources, a second output file is created called the "ungridding" matrix. This file is used by Premobl and Temporal to compute temperatures at a source from the gridded temperature data inputs.

Processing Order

The Smkinven program must be run before the Grdmat program.

For mobile sources only, the Grdmat program must be run before the Premobl and Temporal programs.

The Grdmat program must be run before gridded emissions may be produced using the Smkmerge program.

Input Files

File Name	Source Type	Description
[AREA|MOBL|PNTS]	A, M, P	I/O API inventory files produced by Smkinven program
[A|M|P]SRC	A, M, P	ASCII formatted inventory file produced by Smkinven program
[A|M]GREF	A, M	gridding surrogate cross-reference file in ASCII format
[A|M]GPRO	A, M	gridding surrogate coefficients in ASCII format
G_GRIDPATH	A, M, P	contains description of the modeling grid in ASCII format

MCODES	M	mobile codes for converting road-class to road type and vehicle type name to vehicle type number
MGLNK	M	link definitions file; required if GRDMAT_LINKDEFS=Y. *This file is a future-planned file and is not implemented in the current version of SMOKE.*

Input Environment Variables

- **GRDMAT_ADJUST:** [A, M, P] [default: N]
  Defines whether or not the program uses the grid adjustments file. NOTE: not implemented at this time
  - Y: uses grid adjustments file
  - N: does not use grid adjustments file
- **GRDMAT_LINKDEFS:** [M] [default: N]
  Defines whether or not the program uses a link definitions file for mobile sources. *This option is not implemented in the current version of SMOKE.*
  - Y: uses link definitions file; requires MGLNK input file
  - N: does not use link definitions file
- **REPORT_DEFAULTS:** see Chapter 5, section on Shared Environment Variables.
- **SMK_DEFAULT_SRGID:** [A, M] [default: 50 (Models-3 population) or 1 (if 50 unavailable)]
  Defines the surrogate code number to use as a fallback surrogate when the surrogate number set by the cross-reference file would zero out the emissions for that source.
- **SMK_SOURCE:** see see Chapter 5, section on Shared Environment Variables.

Output Files

- **[A|M|P]GMAT:** (I/O API netCDF) gridding matrix. This matrix contains the factors required by Smkmerge to spatially allocate the input emissions to the grid cells in the modeling domain.
- **MUMAT:** (I/O API netCDF) ungridding matrix output file (mobile sources only)
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype used separate programs for each type of emission source. These programs were GRDAMAT for area sources, GRDMMAT for mobile sources, and GRDPMAT for point sources.

GRWINVEN

Description

Source types: area, mobile, point

The purpose of the Grwinven program is to project and control the inventory emissions into the future by merging a SMOKE inventory file (AREA, MOBL, PNTS) with their respective projection and control matrices. This program is optionally used for future year emissions and activity data projections, but need not be used if these projections have been made outside of SMOKE. It outputs new SMOKE I/O API inventory files, but not the corresponding inventory ASCII files (because the program only changes the data in the I/O API inventory files, so there is no need to output the same ASCII files). The program can also output in IDA format, or be used as a converter from SMOKE to IDA format.

The Grwinven program writes out temporary emissions files when creating an IDA-formatted inventory. The user can set the directory to which these files go by setting the SMK_TMPPATH environment variable. These files can be quite large and at least 100 MB should be available on the disk to which this environment variable is set.

Processing Order

The Grwinven program must be run before the Smkmerge program for area and point sources, and before the Temporal program for mobile sources. It does not have to be run before the Spcmat or Grdmat programs because the number and order of the sources in the grown emissions files are the same as in the basecase, so the gridding and speciation matrices can be shared.

Input Files

File Name	Source Type	Description
[AREA|MOBL|PNTS]	A, M, P	I/O API inventory files produced by Smkinven program
[A|M|P]SRC	A, M, P	ASCII formatted inventory file produced by Smkinven program
COSTCY	A, M, P	Country, state, and county file (to get countries for writing IDA headers)

Input Environment Variables

- **SMK_NUM_CTLMAT:**
  Number of control and/or projection matrices to import and apply to the inventory.
- **SMK_GRWSMKOUT_YN:** [default: Y]
  - Y: outputs SMOKE inventory format.
  - N: does not output SMOKE format.
- **SMK_GRWIDAOUT_YN:** [default: N]
  - Y: outputs Inventory Data Analyzer (IDA) format.
  - N: does not output IDA format.
- **SMK_TMPPATH:** [default: current directory]
  Defines the path to use for temporary files that are written out when supplying the IDA-formatted inventory. This setting is only used when SMK_GRWIDAOUT_YN is set to Y.

Output Files

- **[AREA_O|MOBL_O|PNTS_O]:** (I/O API netCDF) annual and average-day inventory emissions and source characteristics for all inventory data except character string fields.
- **[ARINV_O|MBINV_O|PTINV_O]:** (ASCII) IDA-formatted inventories.
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

LAYPOINT

Description

Source types: point

The Laypoint program uses the SMOKE point sources inventory file with gridded and hourly meteorology data to compute hourly plume rise for all point sources. The plume rise is expressed in terms of layer fractions for each source.

The Laypoint program is needed only for MAQSIP and CMAQ styles of processing, in which all of the plume rise calculations are done prior to input to the air quality model. These models typically use fine vertical resolutions. In Laypoint, meteorological data are used to calculate the plume rise for all point sources. Then, the plume is distributed into the vertical layers that the plume intersects based on the pressure in each layer. Only these fractions are stored (not the emissions in each layer), until the SMOKE merge step (Smkmerge). Therefore, the plume rise calculations do not need to be repeated for each control strategy or grid (unlike the situation in which the plume rise calculations are done inside the air quality model, such as in the UAM-IV and UAM-V). The Laypoint program calculates the plume rise for all days of each meteorological scenario.

Processing Order

For elevated point sources, the Elevpoint program must be run before the Laypoint program if using plume-in-grid and/or specific major point sources.

The Laypoint program must be run before elevated sources may be processed using the Smkmerge program.

Input Files

File Name	Description
GRID_CRO_3D	I/O API netCDF meteorology file produced by the meteorology preprocessor
MET_CRO_2D	I/O API netCDF meteorology file produced by the meteorology preprocessor
MET_CRO_3D	I/O API netCDF meteorology file produced by the meteorology preprocessor

MET_DOT_3D	I/O API netCDF meteorology file produced by the meteorology preprocessor
PELV	ASCII formatted elevated point source identification file produced by Elevpoint
PNTS	I/O API netCDF point source inventory file produced by Smkinven program
PSRC	ASCII formatted point source inventory file produced by Smkinven program

Input Environment Variables

- **REP_LAYER_MAX:** [default: -1]
  integer, layer number for reporting high plume rise; reporting is turned off if set to less than 1
- **SMK_EMLAYS:** see Chapter 5, section on Shared Environment Variables.
- **SMK_SOURCE:** see Chapter 5, section on Shared Environment Variables.

- **SMK_SPECELEV_YN:** [default: N]
  Defines whether or not Elevpoint output file PELV will be used to set elevated sources or not.
  - Y: Use the PELV file to set elevated sources during run.
  - N: Let Laypoint plume rise calculation determine whether or not sources are elevated.

Output Files

- **PLAY:** (I/O API netCDF) SMOKE intermediate file
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

This Laypoint program replaces the LAYPOINT program found in the SMOKE prototype. This version adds support for plume-in-grid models by removing those sources from the point source emissions in the PLAY file.

MRGGRID

Description

The purpose of the Mrggrid program is to combine gridded emission data files, which can be speciated or non-speciated, hourly or time-independent. It can combine any number of 3-d emissions files with any number of 2-d emissions files. In fact, this program will work with any I/O API NetCDF gridded files and need not be used only for emissions files. The program merges whatever data variables are in the input files, and these files can have different data variables. When the variables in two or more files are the same, the values of these data are summed.

Mrggrid checks several features of the input files to ensure that the data in these files are appropriate to be merged together. Mrggrid compares the units of the variables with the same name and it creates and error message when the units are not identical. It is not sufficient to have units that are the same in meaning but different in syntax. For example, although tons/hour and tons/hr are the same, Mrggrid will not recognize that the units are the same because of the different syntax. The user must resolve unit discrepancies before he runs the program. In addition, Mrggrid compares the horizontal grid settings across all 2-d and 3-d files, and these settings must be identical in all respects (e.g., number of cells, grid cell size, grid projection). Finally, Mrggrid checks the layer structures across multiple 3-d files. The 3-d files can have a different number of layers, as long as any layer common to two or more files has the same thickness in each of the files. Mrggrid also checks the I/O API type of vertical structures and top height, and these must be identical across all 3-d files.

The first input file (FILELIST) is simply an ASCII file that contains a list of logical names of the files to merge. This file does not contain the full paths and file names, and should only contain the logical names of the files.

Processing Order

Mrggrid can be used with gridded output files from Smkmerge. It can also be used with other I/O API NetCDF gridded files.

Input Files

File Name	Source Type	Description
FILELIST	N/A	ASCII list file of *logical* file name for 2-d and 3-d gridded I/O API NetCDF files. This file cannot contain the full paths and file names. Users should make sure that

		the logical file names that appear in FILELIST are defined prior to running Mrggrid.

Input Environment Variables

- **NONE**

Output Files

- **OUTFILE:** (I/O API netCDF) gridded, optionally layered, optionally hourly emissions file.
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

NORMBEIS3

Description

Source type: biogenic

Normbeis3 reads gridded land use and emissions factors and produces gridded normalized biogenic emissions. The gridded land use includes 230 different land use types. Emissions factors are provided for each land use type. The output gridded domain is the same as the input domain for the land use data. Emission fluxes are normalized to 30^{o}C, and isoprene and methyl-butenol fluxes are also normalized to a photosynthetic active radiation(PAR) of 1000 umol/m^{2}s. A winter factor is also read in from the emissions factor table and is used to compute normalized emissions for winter months. Normbeis3 outputs winter and summer normalized emissions for all 4 species/compounds listed below as well as winter and summer LAIs for isoprene. The output units for all species/compounds are in grams of carbon per hour, except nitrix oxide is in grams of nitrogen per hour.

Gridded land use can be created using GIS software like ArcInfo. Another tool that can be used to generate gridded land use data is the SMOKE Tool in Models-3 (see Models-3 documentation). The typical database used to generate the BELD3-A, BELD3_B and BELD3_TOT files is the BELD3. Future versions of SMOKE may include a method for creating land use files for use with Normbeis3.

Processing Order

Normbeis3 is the first program for processing biogenic emissions using the SMOKE-BEIS3 prototype. Execute Normbeis3 before Beis3. EPA Models3 program called SMOKE Tool can be executed to generate land use data for use in Normbeis3.

Input Files

File Name	Description
B3FAC	emission factors file in ASCII format
BELD3_A	gridded landuse in netCDF format (first 120 land use types)
BELD3_B	gridded landuse in netCDF format (next 110 land use types)
BELD3_TOT	Land use totals data in netCDF format

Input Environment Variables

- None

Output Files

- **B3GRD:** (I/O API netCDF) gridded, normalized biogenic emissions for 4 chemical compounds and a leaf area index. B3GRD has both summer and winter normalized emissions, so there are a total of 10 variables in this file. Units are in grams of carbon/hour and nitrogen/hour.
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

This is the initial release of the Normbeis3 program, which together with Beis3 program make up the BEIS3 modeling system.

PREMOBL

Description

Source types: mobile

The Premobl program inputs gridded, time-dependent temperature data, an emission factors cross-reference file, and an ungridding matrix produced by the Grdmat program. Premobl determines the minimum and maximum temperatures for each day, source, and emission factor. Ungridding is explain in Chapter 3, Source-Category-Specific Concepts.

Definition of a "day". Premobl seeks to obtain the minimum and maximum temperatures for a source for each day, which is necessary for processing diurnal emissions. However, the definition of a "day" differs for sources in different time zones. By default, Premobl uses each sources time zone to determine a day for that time zone. To use the same day-start-time for all sources, the UNIFORM_TIME environment variable can be used. This option would be used to duplicate emission estimates from the SMOKE prototype.

If the inventory covers multiple time zones, all sources will not have the same coverage of days. Premobl will report the number of missing hours in a day for each time zone in the inventory. The minimum and maximum temperatures per day will be computed without these hours in each time zone, and the user must determine whether this assumption is acceptable. If it is not acceptable, the user must provide additional temperature data to better cover the time period of interest.

Premobl considers daylight time in its determination of “day”. It determines which counties do not have daylight time based on the daylight time flag field in the COSTCY file.

Processing Order

The Smkinven and Grdmat programs must be run before the Premobl program.

The Premobl program must be run before the Emisfac, Temporal, and Smkmerge programs.

The Premobl program is not needed if activity data are not used in the SMOKE mobile inventory file.

Input Files

File Name	Source Type	Description
COSTCY	A, M, P	country/state/county codes file in ASCII format. Used to

		determine counties that do not use daylight time.
MCODES	M	mobile codes file in ASCII format; for converting road class numbers and vehicle type numbers to SMOKE internal standard
MET_CRO_2D OR MET_CRO_3D	M	surface or 3D meteorology file in I/O API netCDF format: - use MET_CRO_2D for surface or 1.5-meter temperature; - use MET_CRO_3D for ambient temperature
MOBL	M	processed source emissions for all but string information in I/O API netCDF format, from Smkinven program
MPLIST	M	the emission factor index list is used to cross-reference which emission factors to use for each source for each of 24 hours
MSRC	M	processed inventory file string information in ASCII format, from Smkinven program
MUMAT	M	ungridding matrix in I/O API netCDF format, from Grdmat program

Input Environment Variables

- **REPORT_DEFAULTS** see Chapter 5, section on Shared Environment Variables.
- **SMK_MAXT_MAX:** [default: 120 (from Mobile5)]
  Defines the maximum allowable maximum daily temperature [degrees F].
- **SMK_MAXT_MIN:** [default: 10 (from Mobile5)]
  Defines the minimum allowable maximum daily temperature [degrees F]
- **SMK_MINT_MAX:** [default: 100 (from Mobile5)]
  Defines the maximum allowable minimum daily temperature [degrees F]
- **SMK_MINT_MIN:** [default: 0 (from Mobile5)]
  Defines the minimum allowable minimum daily temperature [degrees F]
- **SMK_SOURCE:** [default: M] see Chapter 5, section on Shared Environment Variables
- **SMK_TF_INTERVAL:** [default: 2.0]
  Defines the temperature interval in F degrees for computing nondiurnal temperatures.

- **SMK_TF_MAXINTVL:** [default: 40.0 (from Mobile5)]
  Defines the maximum permitted temperature interval in F degrees for min-max difference.

- **TVARNAME:** [default: TEMPG] see Chapter 5, section on Shared Environment Variables.

- **UNIFORM_STIME:** [default: N]
  Logical value to specify if all sources start a day on the same hour or use time zones to determine the start of a day.

  - Y: start all sources on same hour

  - N: use time zones to determine start of day

Other Input

When running Prediur interactively, the following inputs will be requested. The default values for these are set by the G_SDATE, G_STIME, and G_RUNLEN environment variables, as described in Chapter 5, section on Shared Environment Variables.

- **Start date:** Starting date of simulation in Julian (DDDYYYY) or Gregorian (MMDDYYYY) formats

- **Start Time:** Starting time of simulation in HHMMSS.

- **Duration:** Simulation duration in hours.

Output Files

- **MEFTEMP:** Minimum-maximum temperature combinations for each parameter scheme index (PSI) (see Chapter 3, Source-Category-Specific Concepts) in ASCII format.

- **MINMAXT:** Minimum-maximum temperatures by source and day in I/O API netCDF format.

- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype has a similar program called Prediur.

RAWBIO

Description

Source type: biogenic

Rawbio reads the county level biomass/land use or gridded land use, the emissions factors (winter or summer table), and (optionally) gridding surrogate factors, and produces gridded normalized biogenic emissions. When the land use is available only at the county level, the surrogate factors are used to produce gridded land use data. The user can assign a certain surrogate code to be used for each of the following land coverage categories using environment variables:

- pine forest
- deciduous forest
- (other) coniferous forest
- all (other) forest
- agriculture
- grasslands
- wetlands
- other land uses
- leaf area index

The default surrogate code for all of these land coverage categories is 60, which is the EPA Models-3 area surrogate code. If surrogate data exist for these specific land coverage categories, it may be possible to get better results by careful choice of surrogate mapping.

Gridded land use can be created using GIS software like ArcInfo with expertise on how to generate gridding surrogates. Another tool that can be used to generate gridded land use data is the SMOKE Tool in Models-3 (see the Beld3to2 utility program and Models-3 documentation).

Processing Order

Rawbio is the first program for processing biogenic emissions. Execute Rawbio before Tmpbio. Beld3to2 program can be executed to produce gridded landuse for input into Rawbio.

Input Files

File Name	Description
BCUSE	county land use data in ASCII format (optional)
BGUSE	gridded land use data in ASCII format (optional)
BFAC	emission factors file in ASCII format (summer or winter)
BGPRO	surrogates in ASCII format (optional)
G_GRIDPATH	contains description of the modeling grid in ASCII format

Input Environment Variables

- **GLUSE_YN:** [default = N] indicator for using gridded landuse or not
    - Y: uses gridded landuse data
    - N: uses county total landuse data and gridding surrogates
- **PINE_SURG:** [default = 60] surrogate code to use for pine forest allocation
- **DECD_SURG:** [default = 60] surrogate code to use for deciduous forest allocation
- **CONF_SURG:** [default = 60] surrogate code to use for coniferous forest allocation
- **ALLFOR_SURG:** [default = 60] surrogate code to use for all forests allocation
- **AGRI_SURG:** [default = 60] surrogate code to use for agriculture allocation
- **GRASS_SURG:** [default = 60] surrogate code to use for grasslands allocation
- **WETL_SURG:** [default = 60] surrogate code to use for wetlands allocation
- **OTHER_SURG:** [default = 60] surrogate code to use for other land uses allocation
- **LAI_SURG:** [default = 60] surrogate code to use for leaf area index allocation

Output Files

- **BGRD, BGRDW:** (I/O API netCDF) gridded, normalized biogenic emissions. BGRD is

the output when using the summer emissions factor file and BGRDW is the output when using the winter emissions factor file.

- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype version of RAWBIO included an additional input file (BFIP) that contained a list of counties to use from the BCUSE file. This new version creates this list internally automatically using the FIPS codes contained in the surrogates file BGPRO. A BGUSE input file can now be created using the utility program called Beld3to2.

SMKINVEN

Description

Source types: area, mobile, point

Smkinven reads in the raw input data, sorts the records, and creates the SMOKE inventory files that are required by the remainder of the SMOKE programs. Smkinven reads annual, average-day, day-specific, and hour-specific inventory files. The annual and average-day inventory data are combined into a single file, and whether the data started out as annual or average-day data is stored as part of the inventory. This "temporal origin" information is needed by the Temporal program to determine whether or not to apply monthly adjustments. Smkinven call also import gridded 1-layer annual or average day emissions in NetCDF I/O API format. The Smkinven program is run separately for area, mobile, and point sources.

Smkinven writes the SMOKE inventory files. For each source category, two files are written: an ASCII file containing all character-string fields from the inventory, and an I/O API netCDF file containing all numeric data. The character string fields cannot be stored in the I/O API netCDF file because of limitations of the I/O API library. When day-specific and hour-specific data are available (only for point sources), Smkinven can also read these data, and produce separate I/O API NetCDF files for each of the day- and hour-specific data.

Smkinven supports the following file formats and source categories:

- Inventory Data Analyzer (IDA) for area, mobile, point
- IDA mobile extended (modified to support VMT and pollutants)
- EMS-95 area, mobile nonlink (column-specific and list-directed), point
- Special mobile link format
- EMS-95 hour-specific point (can also be used to match with IDA inventories)
- EMS-95 day-specific (modified hour-specific format) point (can also be used to match with IDA inventories)
- ASCII Continuous Emissions Monitoring (CEM) format (hour-specific point source emissions) – when using IDA inventory files for annual or seasonal inventory data.
- EPS2.0 area, mobile (no link), point
- EPS2.0 period-specific point (hour, day, multi-hour, multi-day)

- List format (for combining multiple files of the same format) for area, mobile and point
- Gridded 1-layer annual or average-day NetCDF I/O API emissions data (must be treated as an area source)

For EMS-95 input files, it is not possible to import only day- or hour-specific data. If only such data are to be used, mock annual files must be created. See the PTDAY and PTHOUR file formats for more information on the file formats. The list format is simply a list of file names with paths that allows all files in the list to be processed together. To use a list format, however, all input files must use the same format.

If new sources are added or sources are removed, Smkinven must be rerun for that type of source. However, Smkinven does not need to be rerun when processing additional control scenarios, growth projections, speciation profiles, etc.

When using CEM data, the default CEM files provided with SMOKE are for the whole U.S. and a whole year. This file will take a long time to read in, so users are encouraged to preprocess this data to par it down to the dates and/or sources in the domain. SMOKE can do this if the user does not. The dates can be extracted with the DATERANGE header in the PTHOUR file (see PTHOUR file documentation). The sources in the grid will be selected based on matching to the inventory (if the inventory is for only states within the modeling grid) and/or by the Grdmat program, which will remove sources outside the grid from the model-ready results.

Processing Order

The Smkinven program must be run for a source type (i.e., area, mobile, point) before any other SMOKE programs for that source type.

Input Files

NOTE: All input files for Smkinven are in ASCII format.

File Name	Source Type	Description
ACTVNAMS	M	activity codes and names
[AR|MB|PT]INV	A, M, P	raw inventory file containing source emissions, various formats
PTDAY	P	raw inventory file for day-specific data

PTHOUR	P	raw inventory file for hour-specific data
AG	A	gridded NetCDF I/O API annual or average-day data. This file can be created by Smkmerge or any program that writes gridded data to I/O API format. This file must be time independent.
COSTCY	A, M, P	country, state and county codes file, with time zones
MCODES	M	mobile codes for converting road-class to road type and vehicle type name to vehicle type number
ORISDESC	P	ORIS facility descriptions, needed for getting ORIS facility names for reporting purposes when CEM hour-specific format are read
PSTK	P	replacement stack parameters
SCCDESC	P	SCC descriptions needed for reading CEM hour-specific format only, to select electric generator facilities in the inventory
SIPOLS	A, P	pollutant codes and names

Input Environment Variables

- **DAY_SPECIFIC_YN:** see Chapter 5, section on Shared Environment Variables
- **FILL_ANN_WSEAS:** [A,M,P] [default N]
  Allows annual data to be filled in with seasonal data for IDA formatted inputs.
  - Y: Use when annual emission numbers are blank in IDA-formatted inputs for some records of the inventory but not all records. The emissions values will be filled in using the seasonal (ozone-season) emissions field by multiplying the average-day seasonal number by the number of days in the inventory year (365 or 366). This option is useful when some sources only have annual data and some sources only have seasonal data. Although the annual number will be filled in with the seasonal one, the seasonal emissions will be output from SMOKE as a whole. Note that SMK_O3SEASON_YN should NOT be used in other SMOKE programs when this option has been selected.

  - N: Does not fill in annual data based on seasonal emissions values.

- **HOUR_SPECIFIC_YN:** see Chapter 5, section on Shared Environment Variables

- **HOURLY_TO_DAILY:** [P] [default N]
  Defines whether or not to treat the hour-specific inputs as day-specific data.

  - Y: Uses daily total column only from hour-specific input file, and processes as day-specific data. *This setting does NOT work for input of hour-specific data using CEM format.*

  - N: Treats hourly file as hourly data

- **HOURLY_TO_PROFILE:** [P] [default N]
  Defines whether or not to treat the hour-specific inputs as hour-specific temporal profiles

  - Y: Treats hourly data as temporal profile, and divides each hourly value by value in the daily total column of the file. The values are not renormalized. The resulting hour-specific output file will be recognized by the Temporal program as containing hourly profiles. *This setting does NOT work for input of hour-specific data using CEM format.*

  - N: Treats hourly file as hourly data

- **IMPORT_AVEINV_YN:** [P] [default Y]
  Defines whether or not to import the annual and average-day inventory data. This is set to N to import day-specific or hour-specific data after Smkinven has previously been run for the annual and average-day data.

  - Y: Imports inventory from PTINV file

  - N: Uses SMOKE inventory files from a previous run of Smkinven to get the SMOKE source characteristics to match with the day-specific and hour-specific sources.

- **IMPORT_GRDIOAPI_YN:** [A] [default N]
  Defines whether or not the program will imported a gridded NetCDF I/O API inventory file or not. This setting can only be used with area source processing, and it overrides all other program settings for importing data (e.g., day- and hour-specific data import will be shut off).

  - Y: import gridded I/O API data

  - N: do not import gridded I/O API data

- **RAW_DUP_CHECK:** [A, M, P] [default: N]
  Defines whether or not the program checks for duplicate records in the input file.
    - Y: checks for duplicates, and produces a fatal error if found
    - N: does not check for duplicates, and adds emissions from duplicate records
- **RAW_SRC_CHECK:** [A, M, P] [default: N]
  Defines whether or not the program checks for missing pollutants in records in the input file.
    - Y: Assumes that all sources must have all pollutants, and checks for missing pollutants
    - N: does not check for missing pollutants
- **SMK_DEFAULT_TZONE:** see Chapter 5, section on Shared Environment Variables
- **SMK_MAXERROR:** see Chapter 5, section on Shared Environment Variables
- **SMK_MAXWARNING:** see Chapter 5, section on Shared Environment Variables
- **SMK_SOURCE:** see Chapter 5, section on Shared Environment Variables
- **SMK_SWITCH_EPSXY:** [default: N]
  Defines whetheror not SMOKE should switch XLOC and YLOC fields on input of EPS point source input format. The EPS2.0 file format allows both UTM and lat/lon coordinates. When users provide lat/lon coordinates, the latitude must be placed in the space previously used for the UTM Easting, which is the horizontal location in the grid. This is confusing because latitude is the vertical location. This SMOKE option allows users to correct for input file format errors in which the XLOC and YLOX fields have been switched.
    - Y: switch the format order to be UTM Northing/Longitude then UTM Easting/Latitude
    - N: keep the standard order of UTM Easting/Latitude then UTM Northing/Longitude.
- **SMK_USE_ACTVNAMS:** [M] [defaults in parentheses below]
  Defines whether or not the program uses the activity codes list.
    - Y: uses the activity codes list (default for mobile)
    - N: does not use the activity codes list (default for area and point)

- **SMK_USE_SIPOLS:** [A, M, P] [defaults in parentheses below]
  Defines whether or not the program uses the pollutant list.
  - Y: uses the pollutants list (default for area and point)
  - N: does not use the pollutant list (default for mobile)
- **SMKINVEN_FORMULA:** [A,M,P] [default: blank]
  Allows the user to specify a formula for computing one pollutant value from the values of other pollutants. For example, if the formula is set to "PMC=PM10-PM25", then Smkinven will compute a new variable PMC as the difference between PM10 and PM25. The pollutant characteristics will be taken from the first variable in the formula. The variables used as input in the formula will still be output to the SMOKE inventory file. If the formula is not set, no additional variables will be written to the SMOKE inventory file.
- **VELOC_RECALC:** [P] [default: N]
  Defines whether or not stack velocity is recalculated in order to make the velocity consistent with the reported flow and diameter.
  - Y: recalculates stack velocity
  - N: input stack velocity is stored
- **WEST_HSPHERE:** see Chapter 5, section on Shared Environment Variables
- **WKDAY_NORMALIZE:** [default: N for IDA input format; Y for EMS-95 input format]
  Clarifies the nature of the “average-day” data read in by Smkinven and will impact the Temporal program processing of EMS-95 formatted data of type “AD”, EPS-formated of types “P” and “special”, and IDA-formatted fields for “ozone-season” data. Note that “average-day” data can be “average-annual-day” or “average-season-day”, and this setting will affect Temporal program processing the same.
  - Y: Average-day emissions input to Smkinven are based on *weekday* emissions only. In Temporal, these emissions will be adjusted with weekly profiles normalized with weekdays only (Monday through Friday)
  - N: Average-day emissions input to Smkinven are based on *all days of the week*. In Temporal, these emissions will be adjusted with weekly profiles normalized with all days of the week.

Output Files

- **[AREA|MOBL|PNTS]:** (I/O API netCDF) annual and average-day inventory emissions and source characteristics for all inventory data except character string fields.
- **[A|M|P]SRC:** (ASCII) inventory source characteristics and character-string fields that could not be stored in the netCDF file.
- **PDAY:** (I/O API netCDF) optional day-specific inventory emissions assigned to sources in annual/average-day files.
- **PHOUR:** (I/O API netCDF) optional hour-specific inventory emissions assigned to sources in annual/average-day files.
- **[A|M|P]SCC:** (ASCII) inventory SCCs. This file contains the list of source code categories actually appearing in the raw inventory file.
- **PTREF_ALT:** (ASCII) optional output of temporal profile identification codes per source when EMS-95-formatted point source data are used as input.
- **REPINVEN**: (ASCII) This file is a report for CEM emissions. It is *only output when CEM input emissions are being used*. There is no optional to turn on or off this report, it is simply created when CEM emissions are read. The report includes
    - ORIS IDs from the CEM matched to the inventory
    - ORIS IDs from the CEM not matched to the inventory for mobile)
    - Power generating inventory sources not matched to the CEM
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype used separate programs for each type of source and input file format. These programs included RAWAREA, RAWMOBIL, and RAWPOINT for EPS-formatted files, and EMSAREA and EMSPOINT for EMS-95-formatted files. Also, the SMOKE prototype stored VMT in the MOBL output file; SMOKE 1.0 can store either VMT or emission estimates, if available.

Previous versions of SMOKE v1 did not support hour-specific, day-specific, or EPS2.0 formats.

Previous versions of SMOKE v1 did not support gridded data import.

SMKMERGE

Description

Source types: area, biogenic, mobile, point

The purpose of the Smkmerge program is to combine the matrices produced by the other SMOKE programs and to produce the emissions file for input to the air quality model. The Smkmerge program may be run on any combination of source types (i.e., area, on-road mobile, point, biogenic) and may incorporate temporal, speciation, projection, and spatial processing.

If Smkmerge is run to produce the input files to the air quality model, all the other SMOKE programs must already be run and their output matrices prepared. However, Smkmerge may also be run for the purpose of producing specialized reports. In that instance, only the required SMOKE programs must have been run prior to Smkmerge.

Smkmerge can be used to create 2-d or 3-d gridded, hourly, speciated files. It will also output the hourly emissions file for PinG sources needed by CMAQ. Finally, it will output an ASCII elevated point sources file, suitable for postprocessing with the PTSRCE program of EPS2.0/EPS2.5. If PinG sources have been selected and an ASCII elevated sources is output, then SMOKE will set the diameters to negative values for the PinG sources.

By-day processing. Smkmerge can use a by-day processing approach, to read in one-day hourly files for each day of the week. When the MRG_BYDAY options is set to A, M, P, or any combination of those letters, Smkmerge will read a different logical file name for each day of the week for the hourly emission input files. For example, if MRG_SOURCE is set to "AMBP" and MRG_BYDAY is set to "A", then the hourly input files expected by Smkmerge would be the ATMP_{day} files (see Input Files below for more detail), and the BGTS_[S|L], MTMP, and PTMP files.

The MRG_BYDAY option is useful for implementing a Monday-Weekday-Saturday-Sunday (MWSS) approach to save processing time for episodes of long duration. This approach is useful when weekly temporal profiles used by an inventory do not have variation between Monday and Friday. In the MWSS approach, Monday is processed separately, because time zones differences across a large domain will cause some Sunday emissions for some time zones to be in the Monday file. Additional environment variables other than the defaults in the Assigns file need to be set when this option is applied. Smkmerge will prompt for a different file for each day of the week, but the logical file names for Tuesday through Friday can be defined as the same file to implement a MWSS approach.

Processing Order

All other SMOKE programs prepare input for the Smkmerge program, which must be run last.

Input Files

The input files depend upon the input environment variables that are set for this program. For example, if only area sources are being merged, then only area source-related inputs are required. Similarly, if Smkmerge is being executed to produce speciated, gridded, temporally allocated area and point sources, then all area- and point-related inputs for area and point sources, speciation matrices, gridding matrices, and temporal matrices are required.

File Name	Source Type	Description
ACTVNAMS	M	activity codes and names
BGPRO	B	surrogate for computing biogenic state and county totals from gridded biogenic inputs (BGTS_S or BGTS_L)
[A|M|P]CMAT	A, M, P	multiplicative control matrix in I/O API netCDF format (input if MRG_CTLMAT_MULT is set)
[A|M|P]GMAT	A, M, P	gridding matrix from Grdmat in I/O API netCDF format
[A|M|P]RMAT	A, M, P	mass-based or mole-based reactivity matrix from Spcmat in I/O API netCDF format (input of MRG_CTLMAT_REAC is set)
[A|M|P]SMAT	A, M, P	mass-based or mole-based speciation matrix from Spcmat in I/O API netCDF format
[A|M|P]SRC	A, M, P	SMOKE emissions from Smkinven in ASCII format (string data only)
[A|M|P]TMP	A, M, P	hourly emissions from Temporal in I/O API netCDF format, when MRG_BYDAY is not set for the source category of interest
[A|M|P]TMP_{day}	A, M, P	Hourly emissions from Temporal in I/O API netCDF format, when MRG_BYDAY is set for the source category of interest. {day} = MON, TUE, WED, THU, FRI, SAT, SUN
AREA	A	SMOKE emissions from Smkinven in I/O API netCDF format (non-string data only)

BGTS_ [S|L]	B	Biogenic model-ready emissions, to be input only when merging with other source categories, or when computing biogenic state and county totals
COSTCY	A, B, M, P	country, state and county file with time zones
G_GRIDPATH	A, B, M, P	contains description of the modeling grid in ASCII format
MOBL	M	SMOKE emissions from Smkinven in I/O API netCDF format (non-string data only)
PELV	P	elevated point sources identification file; if using elevated point sources
PLAY	P	SMOKE intermediate file in I/O API netCDF format, output by the Laypoint program
PNTS	P	SMOKE emissions from Smkinven in I/O API netCDF format (non-string data only)
SIPOLS	A, M, P	pollutant codes and names

Input Environment Variables

NOTE: at least one of the MRG_GRDOUT_YN, MRG_REPSTA_YN or MRG_REPCNY_YN environment variables must be set to Y.

- **AREA_SURROGATE_NUM:**
  Surrogate code of the area surrogate in the AGPRO file, to use for totals of biogenic emissions by state and county.

- **MRG_BYDAY:** [default: blank]
  String code that specifies which source categories to use a by-day approach for the hourly input files (see Description section above for more information on this approach). Valid settings include A, M, P, or any combination. For example, set environment variable to "AMP" to have Smkmerge read the area, moibile, and point source hourly emissions files individually for each day.

- **MRG_CTLMAT_MULT:** [default: blank]
  String code that specifies which source categories are processed using a multiplicative control matrix. Valid settings include A, M, P, or any combination. For example, set

environment variable to “M” to have Smkmerge read the mobile source multiplicative control matrix.

- **MRG_CTLMAT_REAC:** [default: blank]
  String code that specifies which source categories are processed using a reactivity control matrix. Valid settings include A, M, P, or any combination. For example, set environment variable to “MP” to have Smkmerge read the mobile and point source reactivity control matrices.

- **MRG_GRDOUT_UNIT:** [default: input file units]
  String code that permits the user to change the units of the gridded output file. For example, "kg/hr" would convert the output emissions to kilograms per hour, before outputting the emissions data. Not all conversions are known, but valid numerators are: "ton", "kg", "mole", and "g". Molar emissions cannot be output without the mole-based speciation matrices. Valid denominators are "yr", "dy", "hr", "s". If annual output is requested but not available in the input file, leap year adjustments are not made.

  Units for CMAQ are moles/s and units for MAQSIP and most other air quality models are moles/hr.

- **MRG_GRDOUT_YN:** [default: N]
  Defines whether or not the program produces the output matrix file.

  - Y: produces the file
  - N: does not produce the file

- **MRG_LAYERS_YN:** [default: N]
  Defines whether or not the program uses the layer fractions file.

  - Y: uses the layer fractions file
  - N: does not use the layer fractions file

- **MRG_MARKETPEN_YN:** [default: Y]
  Defines whether or not the program uses market penetration from reactivity matrices.

  - Y: uses market penetration
  - N: does not use market penetration

- **MRG_METCHK_YN:** [default: Y]
  Defines whether or not the program checks consistency of headers in the meteorology file.

  - Y: checks contents of meteorology file headers
  - N: does not check headers

- **MRG_REPCNY_YN:** [default: N]
  Defines whether or not the program produces a report of emission totals by county
  - Y: produces the report
  - N: does not produce the report

- **MRG_REPCTL_YN:** [default: Y]
  Defines whether or not the program separately reports controlled emissions.
  - Y: reports controlled emissions separately
  - N: does not report controlled emissions separately

- **MRG_REPINV_YN:** [default: Y]
  Defines whether or not the program creates a report using inventory emissions.
  - Y: reports inventory emissions
  - N: does not report inventory emissions

- **MRG_REPSPC_YN:** [default: Y]
  Defines whether or not the program creates a report using speciated emissions. This is not activated in the current version of SMOKE.
  - Y: reports speciated emissions
  - N: does not report speciated emissions

- **MRG_REPSTA_YN:** [default: N]
  Defines whether or not the program produces a report of emission totals by state
  - Y: produces the report
  - N: does not produce the report

- **MRG_SOURCE:** [default: blank (processing halts)]
  Series of character codes representing the type(s) of sources to be merged
  - A: area sources

- B: biogenic sources
- M: on-road mobile sources
- P: point sources
- AP: area and point sources
- AM: area and mobile sources
- etc.

- **MRG_SPCMAT_YN:** [default: N]
  Defines whether or not the program produces speciated output.
  - Y: inputs the speciation matrix produced by the Spcmat program
  - N: does not input the speciation matrix
- **MRG_TEMPORAL_YN:** [default: N]
  Defines whether or not the program produces temporally allocated output
  - Y: inputs the temporal matrix produced by the Temporal program
  - N: does not input the temporal matrix
- **MRG_TOTOUT_UNIT:** [default: input file units, or per day if hourly input is used]
  This variable is like the MRG_GRDOUT_UNIT variable, except that it controls the state and county totals reports separately from the gridded outputs. The only difference is the temporal resolution of MRG_TOTOUT_UNIT, which always outputs the emission values as daily totals, no matter what units are used.
- **SMK_ASCIIELEV_YN:** [default N]
  Defines whether or not the program produces an ASCII elevated point sources file, suitable for postprocessing with the PTSRCE program in EPS2.0/EPS2.5.
  - Y: creates the ASCII elevated point sources file
  - N: does not create the ASCII elevated point sources file
- **SMK_EMLAYS:** see Chapter 5, section on Shared Environment Variables. Used only by Smkmerge to set the default value for UAM_LAYERS, for UAM-V elevated point source output processing.
- **SMK_O3SEASON_YN:** see Chapter 5, section on Shared Environment Variables.

NOTE: This setting only affects the results when not merging with the hourly emissions. To output using hourly seasonal emissions from Smkmerge, this setting must be set to Y for the Temporal program, so that seasonal emissions will be used in creating the hourly emissions.

- **SMK_PING_METHOD:** see Chapter 5, section on Shared Environment Variables. Creates CMAQ PinG file or flags PinG sources in UAM-style elevated ASCII file (when SMK_ASCIIELEV_YN is set to Y).

- **SMK_REPORT_TIME:** [default: 230000]
  Time for writing daily reports from program (HHMMSS)

- **SPC_INPUT:** [script setting,no default]
  This environment variable is used by the SMOKE scripts to switch between mass-based and mole-based speciation. At this time, the Smkmerge program does not read this setting in directly, but rather, the SMOKE scripts use it to control whether Smkmerge will be provided with mass-based or mole-based speciation matrices and biogenic model-ready inputs.

- **UAM_LAYERS:** [default: set by value of SMK_EMLAYS]
  Number of layers to output to elevated point source file for UAM-style processing.

- **UAM_NPARAM:** [default 20]
  Number of parameters for control packet to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_NOTE:** message to appear as a note in the UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_PRINT_LOCATIONS:** [default: 0]
  Flag to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. This flag controls whether PTSRCE will print the locations table. 0=No; 1=Yes. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_PRINT_METHODS:** [default: 0]
  Flag to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. This flag controls whether PTSRCE will print the methods table. 0=No; 1=Yes. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_PRINT_OUTGRD:** [default: 0]
  Flag to appear in UAM-style elevated point source file to be input to UAM preprocessor

PTSRCE. This flag controls whether PTSRCE will print the output grid. 0=No; 1=Yes. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_PRINT_UNITS:** [default: 0]
  Flag to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. This flag controls whether PTSRCE will print the units table. 0=No; 1=Yes. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_PRINT_VALUES:** [default: 0]
  Flag to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. This flag controls whether PTSRCE will print the values table. 0=No; 1=Yes. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_PRINT_VERTMETH:** [default: 0]
  Flag to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. This flag controls whether PTSRCE will print the vertical methods table. 0=No; 1=Yes. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_ PTSRCE_OUTUNIT:** [default 20]
  PTSRCE output file unit number to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM_VERTICAL_METHOD:** [default: STACKHGT]
  Vertical method to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Appropriate values are STACKHGT and PLUMERISE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_DIFFBREAK_UNIT:** [default: 0]
  DIFFBREAK file unit number to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_HTSFC:** [default: 0]
  Height of the surface layer (in meters) to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_HTLOWR:** [default: 20]
  Minimum height (in meters) of cells between the surface and the "diffbreak" to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_HTUPPR:** [default: 100]
  Minimum height (in meters) of cells between the "diffbreak" and the top of the model to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_LAYABOVE:** [default UAMLAYERS - UAM4_LAYBELOW]
  Number of layers above the "diffbreak" to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_LAYBELOW:** [default: 3]
  Number of layers below the "diffbreak" to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_METSCALARS_UNIT:** [default: 15]
  METSCALARS file unit number to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Only used for UAM_VERTICAL_METHOD set to "PLUMERISE". Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_REGIONTOP_UNIT:** [default: 0]
  REGIONTOP file unit number to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_TEMPERATUR_UNIT:** [default: 14]
  TEMPERATUR file unit number to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Only used for UAM_VERTICAL_METHOD set to "PLUMERISE". Relevant only when SMK_ASCIIELEV_YN is set to Y.

- **UAM4_WIND_UNIT:** [default: 16]
  WIND file unit number to appear in UAM-style elevated point source file to be input to UAM preprocessor PTSRCE. Only used for UAM_VERTICAL_METHOD set to "PLUMERISE". Relevant only when SMK_ASCIIELEV_YN is set to Y.

Output Files

The output files produced by Smkmerge are determined by the input environment variables.

- **[A|B|M|P][G][T][S] [_S|_L]:** (I/O API netCDF) data file produced by the program if the MRG_GRDOUT_YN environment variable is set to Y. All file types that can be gridded, must be gridded. For example, the merged area source emissions can be gridded inventory (AG); gridded, hourly inventory (AGT); or gridded, hourly, speciated

emissions (AGTS_L); but not hourly speciated emissions (ATS). The actual file name is determined by the environment variables used to configure the execution of Smkmerge as follows:

- [area|biogenic |mobile|point]
- G = gridded
- T = temporally allocated
- S = speciated
- _S or_L = _S if speciated by mass, _L if speciated by moles

- **PING[T][S][_S|_L]:** (I/O API netCDF) data file produced by the program if the SMK_ELEVPT_YN environment variable is set to Y. The actual file name is determined as shown above for the report file name.
- **ELEVTS[_S|_L]:** (ASCII) data file produced by the program if SMK_ASCIIELEV_YN is set to Y. If PinG sources have also been selected, then the diameters listed in this file will be set to the negative value of their actual value. This allows programs that use this file to determine which sources are PinG sources.
- **REP[A|B|M|P][G][T][S] [_S|_L]:** (ASCII) report file produced by the program if either the MRG_REPSTA_YN or the MRG_REPCNY_YN environment variables are set to Y. The actual file name is determined by the environment variables used to configure the execution of Smkmerge, as listed above.
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype used a series of merge programs - CSELEV for elevated point sources, SDGMERGE for low-level sources, CSGLMERGE for layered output, SMK2EMIS for UAM-ready lower-level emissions, SMK2PTS for UAM-ready elevated point sources, SMK2SAQM for SAQM-ready emissions, and CSGLDAYMERGE. The new Smkmerge program replaces all these special-purpose programs.

SPCMAT

Description

Source types: area, mobile, point

An emission inventory is built and reported for a variety of compounds or chemical classes such as CO, NOx, VOC, PM10, and SO2. However, photochemical mechanisms (e.g., Carbon Bond 4, RADM) contain a simplified set of equations that use representative “model species” to represent atmospheric chemistry. Therefore, source-specific factors are required to convert the emissions from the chemical classes in the emission inventory to the species in the photochemical mechanism. The purpose of the Spcmat program is to produce matrices that contain the factors for converting the input emissions to the species used in the photochemical mechanism of the air quality model.

Spcmat outputs both mass-based and mole-based factors for all sources. Previous systems have assumed that the average molecular weight of the model species was sufficient to represent the molecular weight of a species for a specific source. In fact, the actual molecular weight of a model species if different for different types of emission processes. To represent the mass values more accurately, the mass and mole factors are computed and stored separately.

The speciation cross-reference file specifies the speciation profile to be used for transforming the volatile inventory pollutant to the volatile model species for each source or type of source. Spcmat permits profiles to be assigned based on the country, state, and county code, the source category code, and other source characteristics. A hierarchical system is used to apply the profiles in which the most specific assignments are applied first, followed by the next most specific, etc. Application of the file in SMOKE will always be done so that the most-specific matches override the least-specific ones.

For area sources, the available combinations and their order are the following, starting with the most specific.

1. Country/State/County code and 10-digit SCC code
2. Country/State/County code and 7-digit SCC code
3. Country/State code and 10-digit SCC code
4. Country/State code and 7-digit SCC code
5. 10-digit SCC code
6. 7-digit SCC code

7. Country/State/County code
8. Country/State code
9. Ultimate default

For mobile sources, the available combinations and their order are:

1. Country/State/County code, Road class, Vehicle Type, and Process
2. Country/State/County code, Road class, and Vehicle Type
3. Country/State/County code, Road class, and Process
4. Country/State/County code and Road class
5. Country/State/County code, and Vehicle Type, and Process
6. Country/State/County code and Vehicle Type
7. Country/State code, Road class, Vehicle Type, and Process
8. Country/State code, Road class, and Vehicle Type
9. Country/State code and Road class
10. Country/State code, Vehicle Type, and Process
11. Country/State code and Vehicle Type
12. Road class, Vehicle Type, and Process
13. Road class and Vehicle Type
14. Road class
15. Vehicle Type and Process
16. Vehicle Type
17. Country/State/County code
18. Country/State code
19. Process-specific ultimate default

For point sources, the available combinations depend on the source definition. An optional header has been added to this file format to allow the user to indicate the source definition. (The

header is required for IDA inventories). For IDA-formatted inventories, a source is defined as the unique combination of Country/State/County code, plant ID, point ID, stack ID, segment, and SCC. This documentation applies to IDA-formatted inventories only. "5-digit SCC code" means a 10-digit code with the last 5 digits set to zero. If only 8-digit SCCs are available, these can be used and SMOKE will assume leading zeros. In this case, the "5-digit SCC code" is a "3-digit SCC code."

For point sources, the available combinations and their order are:

1. Country/State/County code, 10-digit SCC code, plant ID, point ID, stack ID, and segment
2. Country/State/County code, 10-digit SCC code, plant ID, point ID, and stack ID
3. Country/State/County code, 10-digit SCC code, plant ID, and point ID
4. Country/State/County code, 10-digit SCC code, and plant ID
5. Country/State/County code and 10-digit SCC code
6. Country/State/County code and 5-digit SCC code
7. Country/State code and 10-digit SCC code
8. Country/State code and 5-digit SCC code
9. 10-digit SCC code
10. 5-digit SCC code
11. Country/State/County code
12. Country/State code
13. Ultimate default

Processing Order

The Smkinven program must be run before the Spcmat program.

The Spcmat program must be executed before speciated emissions may be produced using the Smkmerge program.

Input Files

File Name	Source Type	Description
[AREA|MOBL|PNTS]	A, M, P	I/O API netCDF-formatted inventory files produced by Smkinven program
[A|M|P]SRC	A, M, P	ASCII formatted inventory file produced by Smkinven program
GSCNV	Optional A, M, P	pollutant conversion file in ASCII format (required only if POLLUTANT_CONVERSION = Y)
GSPRO	A, M, P	speciation profiles in ASCII format
GSREF	A, M, P	speciation cross-reference file in ASCII format
MCODES	M	mobile codes file in ASCII format; for converting road class numbers and vehicle type numbers to SMOKE internal standard
MEPROC	M	mobile emission processes file in ASCII format

Input Environment Variables

- **POLLUTANT_CONVERSION:** [A, M, P] [default: N]
  Defines whether or not the program uses the pollutant-to-pollutant conversion file.
  - Y: uses conversion file
  - N: does not use conversion file
- **REPORT_DEFAULTS:** see Chapter 5, section on Shared Environment Variables
- **SMK_GSREF_FIXED:** [A, M, P] [default: N]
  Defines whether the input speciation cross-reference file is in fixed column format or space-delimited format.
  - Y: fixed column format
  - N: space-delimited format

- **SMK_SOURCE:** see Chapter 5, section on Shared Environment Variables
- **SPEC_OUTPUT:** see Chapter 5, section on Shared Environment Variables.

Output Files

- **[A|M|P]SMAT_L:** (I/O API netCDF) mole-based speciation matrix
- **[A|M|P]SMAT_S:** (I/O API netCDF) mass-based speciation matrix
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype used separate programs for each type of emission source. These programs were SPCAMAT for area sources, SPCMMAT for mobile sources, and SPCPMAT for point sources. Also, the SMOKE prototype only output mole-based speciation matrices.

TEMPORAL

Description

Source types: area, mobile, point

The purpose of the Temporal program is to produce a file with the hourly inventory pollutant emissions. Unlike the SMOKE matrices, the output file from Temporal contains the actual emissions data. For all source categories, it uses temporal profiles, temporal cross-references, and the time zone of each source to create the hourly emissions output file. It can also read in day-specific and hour-specific inventory data in SMOKE format, and it uses the most detailed data it can when multiple types of data are available for the same source. For example, if a source had annual, day-specific, and hour-specific data, Temporal would use the hour-specific emissions. The program can also apply source-specific hourly profiles from the hour-specific data file, and it can override all temporal profiles and use uniform profiles for all sources. For mobile sources, Temporal also reads the emission factors created by Emisfac and meteorology data needed to apply the appropriate emission factors for each mobile source.

Temporal treats the temporal profiles as *local* profiles. In other words, the profile applied to the source is adjusted based on the difference between the time zone of the source (determined by the COSTCY file) and the output time zone (determined by the OUTZONE environment variable). SMOKE automatically considers daylight time when converting from a region's standard time zone to the output time zone, and SMOKE can exclude regions that never use daylight time based on the COSTCY file. While temporal has been tested for time zones in the Western Hemisphere, we have not tested it (and it is likely that it will fail) for time zones in the Eastern Hemisphere.

Within the Temporal program, the processing order is as follows:

- Temporal profiles are assigned for all sources.
- Monthly and day-of-week temporal profiles are applied.
- Day-specific emissions or activities are read in and used to overwrite daily emissions for the appropriate sources
- Hourly temporal profiles are applied.
- Hour-specific emissions or activities are read in and used to overwrite hourly emissions for the appropriate sources.
- Emission factors are applied to the hourly activity data (if any)

Hourly temporal profiles can be applied for weekdays and weekend days by default in the system. By breaking up your processing into different periods, a user could apply different temporal profiles for each day of the week. A future version of SMOKE will permit different hourly profiles for every day of the week in a single run of the Temporal program.

A special holidays file should be provided so that holidays will receive special treatment. Currently, SMOKE applies Sunday profiles to holidays.

A many-step hierarchy is used in applying the cross-reference. SMOKE preferentially matches each source to the most-specific line in the cross-reference file. In case of missing entries in the cross reference file, Temporal first looks for cross reference entries for other species at the same level in the search hierarchy before descending to the next level in the hierarchy. For example, if a source has a temporal cross reference entry for CO but not for NO_x, Temporal uses the source-specific CO temporal cross reference entry for allocating NO_x from that source in preference to using an ASC-default NO_x temporal profile.

For area sources, the available combinations are the following, starting with the most specific. "7-digit SCC code" means a 10-digit code with the last three digits set to zero.

3. Country/State/County code, 10-digit SCC code, and pollutant
4. Country/State/County code, 7-digit SCC code, and pollutant
5. Country/State code, 10-digit SCC code, and pollutant
6. Country/State code, 7-digit SCC code, and pollutant
7. 10-digit SCC code and pollutant
8. 7-digit SCC code and pollutant
9. Country/State/County code and 10-digit SCC code
10. Country/State/County code and 7-digit SCC code
11. Country/State code and 10-digit SCC code
12. Country/State code and 7-digit SCC code
13. 10-digit SCC code
14. 7-digit SCC code
15. Country/State/County code
16. Country/State code

17. Ultimate default

For mobile sources, the available combinations are the following. To specify an entry that is to match by vehicle type, the Road class part of the SCC must be filled with zeros. If any warnings or errors are written during the read of the mobile temporal cross-reference file, the messages will use the mobile internal SCCs (see Chapter 3, Source-category-specific concepts).

1. Country/State/County code, Road class, Link ID, Vehicle Type, and Process/Pollutant
2. Country/State/County code, Road class, and Link ID, and Process/Pollutant
3. Country/State/County code, Road class, Link ID, and Vehicle Type
4. Country/State/County code, Road class, and Link ID
5. Country/State/County code, Road class, Vehicle Type, and Process/Pollutant
6. Country/State/County code, Road class, and Process/Pollutant
7. Country/State/County code, Vehicle Type, and Process/Pollutant
8. Country/State code, Road class, Vehicle Type, and Process/Pollutant
9. Country/State code, Road class, and Process/Pollutant
10. Country/State code, Vehicle Type, and Process/Pollutant
11. Road class, Vehicle Type, and Process/Pollutant
12. Road class and Process/Pollutant
13. Vehicle Type and Process/Pollutant
14. Country/State/County code, Road class, Vehicle Type
15. Country/State/County code, Road class
16. Country/State/County code, Vehicle Type
17. Country/State code, Road class, Vehicle Type
18. Country/State code, Road class
19. Country/State code, Vehicle Type
20. Road class, Vehicle Type
21. Road class

22. Vehicle Type
23. Country/State/County code
24. Country/State code
25. Ultimate default

For point sources, the available combinations depend on the source definition. An optional header has been added to this file format to allow the user to indicate the source definition. (The header is required for IDA inventories). For IDA-formatted inventories, a source is defined as the unique combination of Country/State/County code, plant ID, point ID, stack ID, segment, and SCC. This documentation applies to IDA-formatted inventories only. "5-digit SCC code" means a 10-digit code with the last 5 digits set to zero. If only 8-digit SCCs are available, these can be used and SMOKE will assume leading zeros. In this case, the "5-digit SCC code" is a "3-digit SCC code."

The hierarchy of cross-referencing is the following.

1. Country/State/County code, 10-digit SCC code, plant ID, point ID, stack ID, segment, and pollutant
2. Country/State/County code, 10-digit SCC code, plant ID, point ID, stack ID, and pollutant
3. Country/State/County code, 10-digit SCC code, plant ID, point ID, and pollutant
4. Country/State/County code, 10-digit SCC code, plant ID, and pollutant
5. Country/State/County code, 10-digit SCC code, plant ID, point ID, stack ID, and segment
6. Country/State/County code, 10-digit SCC code, plant ID, point ID, and stack ID
7. Country/State/County code, 10-digit SCC code, plant ID, and point ID
8. Country/State/County code, 10-digit SCC code, and plant ID
9. Country/State/County code, 10-digit SCC code, and pollutant
10. Country/State/County code, 5-digit SCC code, and pollutant
11. Country/State code, 10-digit SCC code, and pollutant
12. Country/State code, 5-digit SCC code, and pollutant
13. 10-digit SCC code, and pollutant

14. 5-digit SCC code, and pollutant
15. Country/State/County code and 10-digit SCC code
16. Country/State/County code and 5-digit SCC code
17. Country/State code and 10-digit SCC code
18. Country/State code and 5-digit SCC code
19. 10-digit SCC code
20. 5-digit SCC code
21. Country/State/County code
22. Country/State code
23. Ultimate default

Processing Order

The Smkinven program must be run before the Temporal program. For mobile sources, the Grdmat, Prediur, and Emisfac programs also must be run before the Temporal program when activity data are being used.

The Temporal program must be run before gridded, hour-specific emissions may be produced using the Smkmerge program.

Input Files

File Name	Source Type	Description
[AREA|MOBL|PNTS]	A, M, P	I/O API netCDF inventory files produced by Smkinven program
[A|M|P]DAY	Optional, A, M, P	day-specific input file in I/O API netCDF format (required if DAY_SPECIFIC_YN environment variable is set to Y)

[A|M|P]HOUR	Optional, A, M, P	hour-specific input file in I/O API netCDF format (required if HOUR_SPECIFIC_YN environment variable is set to Y)
[A|M|P]SRC	A, M, P	ASCII formatted inventory file produced by Smkinven program
[A|M|P]TPRO	A, M, P	temporal profiles in ASCII format. Study Planner uses GTPRO
[A|M|P]TREF	A, M, P	temporal cross-reference file in ASCII format. Study Planner uses GTREF
COSTCY	A, M, P	country/state/county codes file in ASCII format. Used to determine counties that do not use daylight time.
HOLIDAYS	A, M, P	holidays file by Gregorian date for applying holiday temporal profiles.
MEFSND	Optional, M	nondiurnal emissions input file in I/O API netCDF format
MET_CRO_2D OR MET_CRO_3D	Optional, M	surface temperature file in I/O API netCDF format. This file is available from the meteorology preprocessor.
MINMAXT	Optional, M	ungridded minimum/maximum temperature file in I/O API netCDF format
MPLIST	Optional, M	emission factor cross-reference file in ASCII format
MUMAT	Optional, M	ungridding matrix in I/O API netCDF format
MEPROC	M	mobile emission processes file in ASCII format
MCODES	M	mobile codes file in ASCII format; for converting road class numbers and vehicle type numbers to SMOKE internal standard

Input Environment Variables

- **DAY_SPECIFIC_YN:** see Chapter 5, section on Shared Environment Variables
- **HOUR_SPECIFIC_YN:** see Chapter 5, section on Shared Environment Variables
- **OUTZONE:** see Chapter 5, section on Shared Environment Variables
- **RENORM_TPROF:** [A, M, P] [default: Y]
  Defines whether this program normalizes the temporal profiles or uses them as they exist in the data file. If the profiles are specified as decimal values and sum to 1, then specify **N**. Otherwise, specify **Y** and the program will sum the values associated with each profile and then divide each value by the sum, thereby creating a normalized profile.
  - Y: normalizes the temporal profiles
  - N: uses the temporal profile values as they exist in the data file
- **REPORT_DEFAULTS:** see Chapter 5, section on Shared Environment Variables
- **SMK_EF_MODEL:** [default: MOBILE5]
  Name of the emission factor model to use. NOTE: Only the default value may be used.
- **SMK_ELEVPT_YN:** [P] [default: N]
  Defines whether or not this program generates an elevated point source output file. NOTE: This option is not implemented in the current version. An elevated emissions output file will not be generated.
  - Y: generates an elevated point source file for UAM-style processing. Reads in the PELV file
  - N: does not generate an elevated point source file for UAM-style processing. Reads in the PELV file
- **SMK_MAXERROR:** see Chapter 5, section on Shared Environment Variables
- **SMK_MAXWARNING:** see Chapter 5, section on Shared Environment Variables
- **SMK_O3SEASON_YN:** see Chapter 5, section on Shared Environment Variables
- **SMK_SOURCE:** see Chapter 5, section on Shared Environment Variables
- **TVARNAME:** [default: TEMPG]
  The name of the temperature variable to use for temperatures read by the program.

- **UNIFORM_TPROF_YN:** [default: N]
  Defines whether or not to use uniform temporal profiles for all sources
  - Y: Use uniform temporal profiles
  - N: Use temporal profiles file and temporal cross-reference file
- **ZONE4WM:** [A, M, P] [default: Y]
  Defines whether or not this program applies weekly and monthly temporal profiles using time zones. If SMOKE does not apply the profiles using the sources time zones, then all sources change from one day to the next or one month to the next at the same hour. This is what other emission processing systems have typically done, and it is a minor distinction in most cases.
  - Y: uses time zones
  - N: does not use time zones

Other Input

When running Temporal interactively, the following inputs will be requested. The default values for these are set by the G_SDATE, G_STIME, and G_RUNLEN environment variables, as described in Chapter 5, section on Shared Environment Variables.

- **Start date:** Starting date of simulation in Julian (DDDYYYY) or Gregorian (MMDDYYYY) formats
- **Start Time:** Starting time of simulation in HHMMSS
- **Duration:** Simulation duration in hours

Output Files

- **[A|M|P]TMP:** (I/O API netCDF) hourly emissions file. This file contains the hourly emissions by source required by Smkmerge. If using elevated point sources and processing point sources, this file contains only the layer-1 emissions.
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype used separate programs for each type of emission source. These programs were TMPAREA for area sources, TMPMOBIL for mobile sources, and TMPPOINT

for point sources. The TMPAREA, TMPMOBIL, and TMPPOINT programs used ESDATE, STIME, and DURATION environment variables to set the default date, time, and duration; SMOKE v1.0 now uses the G_SDATE, G_STIME, and G_RUNLEN environment variables used by other programs in the Models-3 environment.

Also, the SMOKE prototype permitted pollutant-specific temporal profiles for point and mobile sources, but not for area sources. Starting with SMOKE v1.0, area, mobile, and point sources may use pollutant-specific temporal profiles. SMOKE v1 now handles pollutants other than CO, NOX, and VOC or ROG. All source categories can have day- and hour-specific emissions, whereas the prototype allowed this only for point sources.

TMPBIO

Description

Source type: biogenic

Tmpbio reads the gridded, normalized emissions file BGRD and/or BGRDW, as well as meteorological data either from MET_FILE1 and/or MET_FILE2 (MET_CRO_2D or MET_CRO_3D). Speciation profiles are used to speciate biogenic pollutants into appropriate chemical mechanisms. The CB-IV and RADM2 mechanisms are supported. The normalized emissions and meteorological data are used to produce gridded, speciated, hourly biogenic emissions. Additionally, an optional seasonal switch file, BIOSEASON, can be used to determine when and where to use summer or winter normalized emissions data on a daily basis. The user must input both the BGRD and BGRDW files if the seasonal switch file is used.

Processing Order

Execute Rawbio before Tmpbio.

If using the seasonal switch option, Rawbio must be executed twice (once using the summer emissions factor file and once using the winter emissions factor file). Also, the seasonal switch file must be created using Metscan.

Tmpbio must be executed before using biogenic emissions in Smkmerge.

Input Files

File Name	Description
BGRD, BGRDW	gridded, normalized biogenic emissions in I/O API netCDF format, from Rawbio
GRID_CRO_2D	meteorology file in I/O API net CDF format; contains latitude and longitude coordinates for each grid cell (optional)
GSPRO	Speciation profiles file (ASCII)
MET_FILE1	meteorology file in I/O API net CDF format; contains temperature data and possibly radiation/cloud data as well (see BIOMET_SAME environment variable)
MET_FILE2	meteorology file in I/O API net CDF format; contains radiation/cloud data if

	not in MET_FILE1 (optional)
BIOSEASON	Gridded seasonal switch file in I/O API netCDF; contains daily data with 0 meaning use winter normalized emissions and 1 meaning use the summer normalized emissions, from Metscan (optional)

Input Environment Variables:

- **BG_CLOUD_TYPE:** [default = 1] specifies which meteorological data to use
    - 1: uses RGND or RSD (solar radiation reaching the ground) from MM5 to calculate PAR
    - 2: uses MM5 Kuo cloud fractions and surface pressure data to calculate PAR (untested)
    - 3: uses MM5 Kain-Fritsch cloud fractions and surface pressure data to calculate PAR (untested)
    - 4: uses MM5 cloud fractions with no deep convection parameterization and surface pressure data to calculate PAR (untested)
    - 5: assumes clear skies when calculating PAR needs GRID_CRO_2D file for solar zenith angle calculation (latitude-longitude coordinates)
- **TMPR_VAR:** [default: TA] specifies variable name for temperature to extract from MET_FILE1
- **BIOMET_SAME:** [default: FALSE] indicates whether or not the radiation/cloud data is in same file as the temperature data, MET_FILE1 or a different file, MET_FILE2
- **RAD_VAR:** [default: RGRND] specifies variable name for radiation/cloud data to extract from either MET_FILE1 or optional MET_FILE2
- **BIOG_SPRO:** [default: '0000'] specifies the speciation profile for biogenic emissions from GSPRO
- **BIOSW_YN:** [default: TRUE] indicates whether or not the user wants to input a gridded seasonal switch file
- **OUTZONE:** see Chapter 5, section on Shared Environment Variables

Output Files

- **BGTS_L:** (I/O API netCDF) gridded, speciated, hourly biogenic emissions; units in moles/hr
- **BGTS_S:** (I/O API netCDF) gridded, speciated, hourly biogenic emissions; units in tons/hr
- **LOGFILE:** (ASCII) This file contains the log generated from executing this program.

Earlier Versions

The SMOKE prototype version of Tmpbio only supported UAM-BEIS2 processing for the Carbon Bond-IV mechanism. The prototype Tmpbio also allowed for National Weather Service observational data to be used in estimating emissions. This option is not available in this version due to lack of interest. Options 2, 3 and 4 above that use cloud fraction data have not been fully tested in this new version. Strongly recommend setting BG_CLOUD_TYPE to 1. The CB-IV speciation has been tested with this new version. The RADM2 mechanism speciation has been processed with this new version, but has not been fully benchmarked. The OUTZONE environment variable was not in the prototype version of Tmpbio; the output time zone was the same as the meteorological data. SMOKEv1.2 and earlier versions did not allow the input of a gridded seasonal switch file.