

Recent Updates to the SMOKE Modeling System

Bok H. Baek, Alison Eyth, and Andy Holland
Carolina Environmental Program, University of North Carolina at Chapel Hill
137 E. Franklin St., Chapel Hill, NC 27599-6116
bbaek@email.unc.edu

ABSTRACT

EPA's Office of Air Quality Planning and Standards is developing the one-model framework for toxics and criteria modeling for all air quality models used by U.S. EPA, including CMAQ, CAMx, REMSAD, and AERMOD. In addition, OAQPS is developing an Emission Modeling Framework (EMF) to provide better management, versioning, quality assurance, and tracking of data used for emissions modeling. The Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system is used to prepare emissions input data for many of the models used by U.S. EPA. SMOKE has been enhanced in FY05 and FY06 to better support the integration with the EMF and the one-model framework, which includes the improved integration of toxics and criteria modeling. Many updates in support of this effort have been completed, and others are currently underway or planned for the remainder of FY06 and for FY07. Updates to SMOKE v2.2 include processing data for variable grid resolutions and integration with the BlueSky fire emissions estimates model. SMOKE v2.3 significantly reduces memory requirements during gridding, can model non-sequential episodes within a single run of Temporal, supports an extended one record per line (ORL) format, and includes a new approach to wildfire inventories. Additional details regarding the usage of the new versions of SMOKE are available at www.cmascenter.org under the model documentation section. Upcoming updates to be discussed include enhancements to allow SMOKE to produce outputs for various toxics models such as ASPEN, ISCST3, and AERMOD.

INTRODUCTION

Emissions modeling is a very complex and difficult process. It requires the wide range of knowledge and experience to process emission inventories into data that can be used by air quality models (AQMs) used. The emission modeling process includes reading emission inventories and applying chemical speciation, temporal allocation, spatial allocation, growth, and control factors. Figure 1 represents the parallel approach to emission processing in the SMOKE modeling system to create a set of model-ready output for an air quality model. During this process, SMOKE creates matrices of speciation factors, gridding factors, and control factors, and a vector of hourly emissions. These are then multiplied together to create AQM-ready input data. This document refers to enhancements to a number of SMOKE programs that are used in this process. The roles of the programs are as follows:

- **Smkinven** performs the import inventory step during which quality assurance of the inventory is performed and the data is written into a file format used by SMOKE for efficient processing.
- **Spcmat** performs the speciation of emission inventory species (e.g., VOC, NO_x) into species used by the air quality model (e.g. NO, NO₂, Isoprene, Toluene).
- **Grdmat** performs spatial allocation of emission inventory sources from points, counties, and roads into grid cells used by most air urban-regional scale AQMs.
- **Grwinven** applies growth factors to adjust emission inventory data between years.
- **Cntlmat** applies control factor to simulate the implementation of control strategies that reduce emissions.

- **Temporal** performs temporal allocation of the sources in the emissions inventory to convert them from annual or daily values into the hourly values needed by an AQM.
- **Smkmerge** merges the control, gridding, and speciation matrices with the temporalized vector of emissions values to create the grown, controlled, speciated, hourly emissions needed by the AQM.

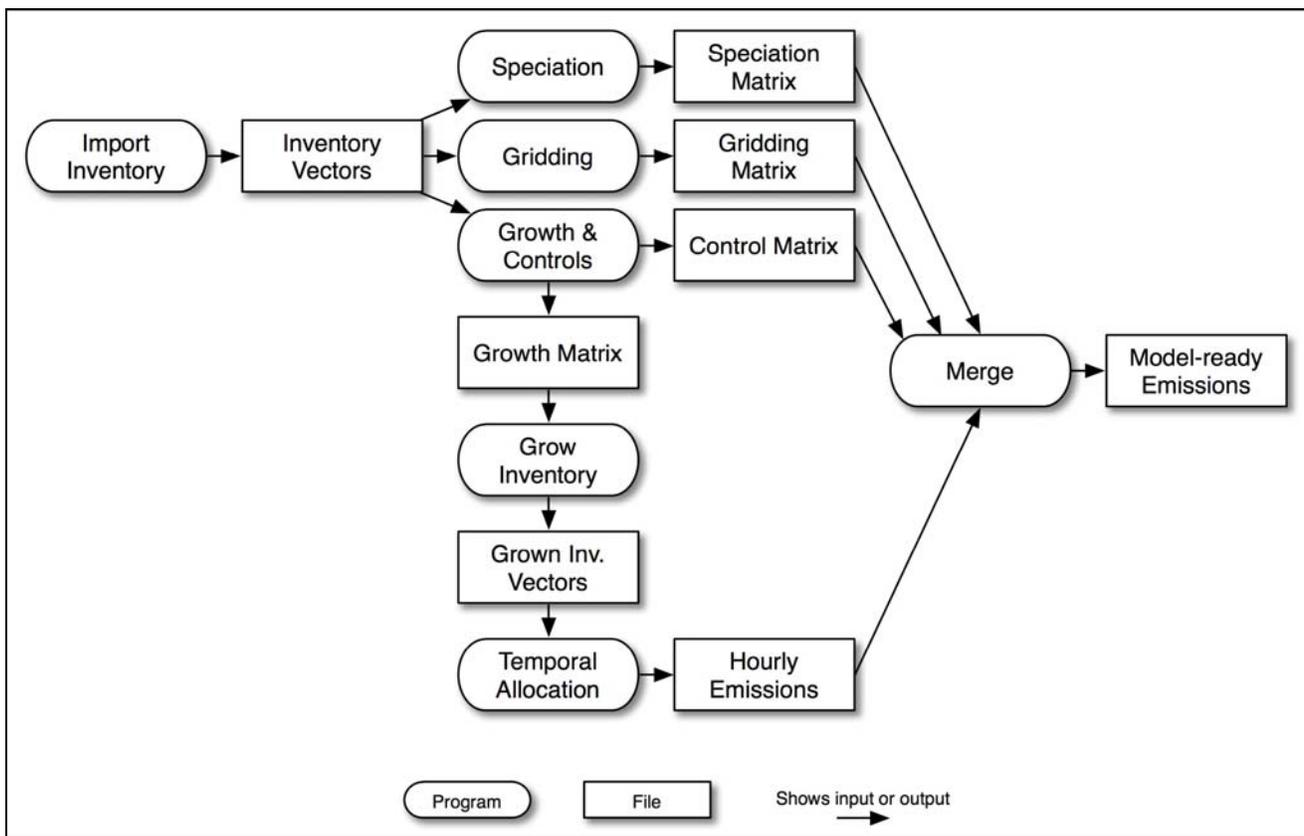


Figure 1. Parallel approach to emissions processing in the SMOKE modeling system.

A goal of the EMF is to provide better management and tracking of data used for emissions modeling and for the inputs and settings used to prepare emissions data input to air quality models. A key component used by the EMF is the SMOKE modeling system, which processes emissions inventories and related data into formats needed by air quality models. SMOKE has been enhanced in recent years to facilitate the further integration of toxics and criteria processing within a one-model framework and to support better integration with the EMF (Houyoux *et al.*, 2005). Many updates in support of this effort have been completed (Seppanen, 2005) and others are currently underway or planned for the remainder of FY06 and for FY07. SMOKE version 2.2 was released in September, 2005, and SMOKE version 2.3 is planned for a release during the summer of 2006. This document describes the updates made in SMOKE version 2.2 and ongoing updates in SMOKE version 2.3. It also discusses prospective updates to SMOKE that have been identified during the design of the EMF and the one-model framework. More details regarding to the most updated version of SMOKE are available at www.cmascenter.org.

SMOKE V2.2 UPDATES

Summary of Version 2.2 Updates

SMOKE version 2.2 was initially released in September 2005, and an additional update to this was released in November 2005. Details of the updates are described later in this section, but a summarized list of updates is as follows:

1. SMOKE was enhanced to better support wildfire emissions by adding an interface to the BlueSky modeling framework which also included new plume rise algorithms.
2. Improved support for Continuous Emissions Monitoring (CEM) data.
3. Enhanced support for CAMx (Comprehensive Air Quality Model with Extensions).
4. A program for windowing emissions from those on larger grids was added.
5. New options and details have been added to SMOKE's reporting feature.
6. A flexible mapping scheme for aggregation MOBILE6 vehicle types to inventory types was implemented.
7. Other updates, such as the setting of criteria to group point sources, were implemented.

In addition to these software updates, a new and improved set of test case data for SMOKE was developed and released, and the SMOKE scripts and assigns files were updated to go along with the new test case and new features. This new test case is more relevant to today's modeling studies.

BlueSky Integration

SMOKE v2.2 is compatible with the EPM/CONSUME model in the BlueSky modeling framework, used to estimate emissions from wildfires. The SMOKE utility program **BlueSky2Inv** can read the emissions estimates output from BlueSky and create the annual and daily inventory files needed by SMOKE. It also computes PMC which is calculated as $PM_{10}-PM_{2.5}$, and TOG, which is calculated as CH_4+NMHC (non-methane hydrocarbons). Wildfires in the inventory are treated as point sources in SMOKE. When running BlueSky, users must provide state and county codes and SCCs in the BlueSky input. This data will be output by BlueSky and allow **BlueSky2Inv** to create SMOKE inventory files with the necessary information. A sample **BlueSky2Inv** output file is listed below. Additional details about **BlueSky2inv** are available at <http://www.cep.unc.edu/empd/products/smoke/bluesky>.

```
#IDA
#TYPE    Fire Event Inventory
#COUNTRY US
#YEAR    2001
#DATA AREA HFLUX PM2_5 PMC CO TOG
12 212001-17-0255          1
2810001000
26.0580 -81.5470

The daily inventory entries for area, heat flux, PM2.5, PM10, CO, and TOG are as follows:

#COUNTRY US
12 212001-17-0255          1          AREA 05/21/01EST          1083.00000 2810001000
12 212001-17-0255          1          HFLUX05/21/01EST          53900845056.0 2810001000
12 212001-17-0255          1          PM2_505/21/01EST          25.02788 2810001000
12 212001-17-0255          1          PMC 05/21/01EST          2.90041 2810001000
12 212001-17-0255          1          CO 05/21/01EST          216.61856 2810001000
12 212001-17-0255          1          TOG 05/21/01EST          17.03279 2810001000
```

Figure 2. A sample BlueSky2Inv output file.

As a part of Bluesky integration, new BlueSky Pouliot-Godowitch plume rise algorithm [1] has been added to **Laypoint** to calculate plume rise for wildfires using area burned and pre-computed heat flux of each wildfire (Pouliot *et al.*, 2005). The traditional plume rise calculation in **Laypoint** must be separately processed from the wildfire emissions. With this equation [1], both a plume top and a plume bottom are calculated using this layer by layer approach.

$$BE_{size} = 0.0703 * \ln(acres) + 0.3 \quad (1)$$

where BE_{size} = buoyant efficiency and $acres$ = fire size in acres. However, to account for smoldering we have distributed the emissions into the layers below the plume bottom as well as into the layers between the plume top and bottom. This effectively permits emissions to be at all model layers up to the plume top. A smoldering fraction of the total emissions is used to split the emissions into a smoldering part (distributed into the layers below the plume bottom) and the remaining part (distributed into the layers between the plume bottom and plume top). Pouliot *et al.* (2005) derived a relationship between the Bouyant Efficiency (the portion of heat release from a fire that produces buoyancy, BE) and fire size by calculating a “best fit” curve using a simplification of the Western Regional Air Partnership (WRAP) method for estimating the smoldering fraction: [2]

$$S_{fract} = 1 - BE_{size} \quad (2)$$

Improved CEM Support

In SMOKE v2.2, CEM data can be imported in a new format and an updated approach uses hourly heat input values from the CEM data to allocate annual emissions to hourly data. The **CEMScan** program calculates summed annual NO_x emissions, SO₂ emissions, heat input, gross load, and steam load from a year’s worth of CEM data (Table 1). The output from **CEMScan** is then used by **Smkinven** to calculate hourly emissions from annual inventory data when processing CEM data.

Table 1. CEM format for individual hour-specific data file.

Position	Name	Type	Description
A	ORISID	Char (6)	DOE Plant ID (required) (should match the same field in the PTINV file in IDA format)
B	BLRID	Char (6)	Boiler Identification Code (required) (should match the same field in the PTINV file in IDA format)
C	YYMMDD	Int	Date of data in YYMMDD format (required)
D	HOUR	Integer	Hour value from 0 to 23
E	NOXMASS	Real	Nitrogen oxide emissions (lb/h) (required)
F	SO2MASS	Real	Sulfur dioxide emissions (lb/h) (required)
G	NOXRATE	Real	Nitrogen oxide emissions rate (lb/MMBtu) (not used by SMOKE)
H	OPTIME	Real	Fraction of hour unit was operating (optional)
I	GLOAD	Real	Gross load (MW) (optional)
J	SLOAD	Real	Steam load (MW) (optional)
K	HTINPUT	Real	Heat input (MMBtu) (required)

Enhanced CAMx Support

SMOKE v2.2 provides a more streamlined approach to producing outputs for CAMx, REMSAD, and UAM models which do not require layer fractions output. A new utility program **Mrgelev** can

combine multiple ASCII elevated files produced by **Smkmerge** into a single binary elevated file. **Mrgelev** also handles matching PinG sources from different inputs. For PinG matching, **Mrgelev** uses PELV elevated point sources information output by **Elevpoint**. **Mrgelev** uses the environment variable MRG_DIFF_DAYS to merge files from different days into a single file.

Windowing of Emissions

The new program **Aggwndw** aggregates and/or windows emissions from an I/O API file to a new grid. The program does not change grid projections or interpolate data. The grid boundaries of the input and output grids must be aligned and the output grid must be entirely contained within the input grid. **Aggwndw** automatically checks that the input and output emissions do not differ by more than 0.01% and also produces a report file containing summed input and output data.

Improved Reporting

New options were added to **Smkreport**, the SMOKE reporting program. These include: (1) reporting of emissions at different SCC levels, (2) inclusion of source location coordinates in reports, (3) the ability to use custom labels in reports, and (4) other options such as BY MACT, BY NAICS, and BY SRCTYPE. The form of the data output from **Smkreport** is controlled by a configuration file called the REPCONFIG file. Within this file a number of keywords are used to define the format of the resulting report. Some details regarding the impact of these new options on the REPCONFIG files follow.

(1) When reporting by SCC level, new options for the REPCONFIG file are:

- BY SCC [N] [NAME]: Records are printed and summed by all or part of the SCC depending on the value of N which can be set to 1, 2, 3, or 4. When N = 4, the full SCC is used. If no value is given, N is 4 by default. The [NAME] option can be used for any N value. The name is truncated assuming that semi-colons separate the different parts of the SCC descriptions.
- BY SCC10 [NAME]: This option maintains backward compatibility with previous versions of SMOKE. It is the same as the BY SCC [N] [NAME] option with N = 4.

(2) When reporting source coordinates in reports; new options for the REPCONFIG file are:

- BY SOURCE [LATLON]: The LATLON option prints each source's x- and y coordinates in the output report, otherwise the coordinates are reported using the units of the modeling grid's map projection. This option can be used in conjunction with the other BY SOURCE options: [STACKPARAM] and [NAME].

(3) When reporting using the new /SET LABEL/ packet, a label that will be included on every row of every subsequent report defined in the REPCONFIG file. The syntax for the packet is /SET LABEL/ <label> where <label> is limited to 200 characters and can be a string of text, an environment variable (starting with a dollar sign), or the word "OFF" (indicating that no label should be used for subsequent reports).

(4) Previous versions of **Smkreport** could use inventory information such as SCC and SIC when generating emissions reports but can not newer toxics-related codes. New options were added to the BY instruction for MACT, NAICS, and SRCTYPE. The options work as follows:

- BY MACT [NAME] : Records are printed by MACT code and can optionally include MACT description.

- BY NAICS [NAME] : Records are printed by NAICS code and can optionally include NAICS description.
- BY SRCTYPE: Records are printed by source type; the source type is used by SMOKE in determining applicable MACT-based controls. Valid values are 01 = major source and 02 = Section 12 area source.

Improved MOBILE6 Mapping

In the current integration of SMOKE with MOBILE6, MOBILE6 produces emissions factors for a total of 28 vehicle types. For SMOKE to assign these emission factors to the mobile sources, the emission factors had to be aggregated to 8 vehicle types. However, in recent updates in the integration of SMOKE with MOBILE6, this feature has been enhanced to support custom mapping of MOBILE6 vehicle types to SMOKE inventory types using the M6MAP input file. A format and sample of M6MAP file is shown below (Table 2):

Table 2. Format for M6MAP file.

Position	Name	Type	Description
A	M6TYPE	Char (6)	MOBILE6 vehicle type
B	INVTTYPE	Char (6)	Inventory vehicle type

```
# MOBILE6 to SMOKE vehicle type mapping file
# base 8 vehicle types from SMOKE User's Manual
LDGV      LDGV
LDGT1     LDGT1
LDGT2     LDGT1
LDGT3     LDGT2
LDGT4     LDGT2
HDGV2b    HDGV
HDGV3     HDGV
HDGV4     HDGV
HDGV5     HDGV
HDGV6     HDGV
HDGV7     HDGV
HDGV8a    HDGV
HDGV8b    HDGV
HDGB      HDGV
LDDV      LDDV
LDDT12    LDDT
LDDT34    LDDT
HDDV2b    HDDV
HDDV3     HDDV
HDDV4     HDDV
HDDV5     HDDV
HDDV6     HDDV
HDDV7     HDDV
HDDV8a    HDDV
HDDV8b    HDDV
HDDBT     HDDV
HDDBS     HDDV
MC        MC
```

Other Updates

Some additional updates to SMOKE were implemented, and a new test case of data was developed that is based on a 36km grid that aligns with many of EPA's recent modeling efforts. This allows EPA's current set of more than sixty spatial surrogates to be used, along with other ancillary files that have been updated more recently than the data used in the previous test cases. The SMOKE Assigns file and scripts were updated to accompany the new test case, such as using the new MOBILE6-to-inventory

mapping file (M6MAP), MACT descriptions file (MACTDESC), and NAICS descriptions file (NAICSDESC).

SMOKE V2.3 UPDATES

Summary of SMOKE Version 2.3 Updates

Work on SMOKE version 2.3 started early in FY06. It is expected to continue through late spring of 2006, with a public release scheduled for early summer. A summary of the updates is the following:

1. The amount of memory required for gridding was substantially reduced, and spatial surrogates are now provided in multiple files.
2. Support for non-sequential temporal processing was added to the Temporal program to improve ease of use for long modeling studies.
3. Several revisions to inventory processing were implemented, including updates to the one record per line (ORL) format which facilitate its use for both criteria and toxics modeling in conjunction with the 2002 National Emissions Inventory.
4. Minor updates to Growth and Control processing were implemented.
5. A new update for processing wildfires using new ORL FIRE and day-specific ORL FIREEMIS formatted files is underway.

Memory Reductions for Gridding

The previous implemented gridding approach required large amounts of memory as the number of surrogate codes and grid cells used for modeling increased. This was because the data for all surrogates for the entire grid was read into memory at one time. In SMOKE v2.3, **Grdmat** was updated to process only the surrogate codes that were actually used in the cross reference one at a time. The surrogates can be stored either in one file or in multiple files. As a result of this update, Grdmat requires approximately 90% less memory to run than it did in previous versions, depending on the number of surrogate codes and grid cells used.

As a result of this update, the environment variables AGPRO and MGPRO are no longer used to specify the names of the area and mobile spatial surrogate files. Instead, a new environment variable, SRGPRO_PATH, points to the directory that contains the surrogate file(s) and a new file called SRGDESC is used to specify the names of the files containing the spatial surrogate files. The SRGDESC file also specifies the numeric surrogate code and the region to which the surrogate file applies (Table 3). A new tool called the Surrogate Tool was developed as part of the EMF effort and can be used to more easily generate spatial surrogates and the SRGDESC files (Eyth *et al.*, 2005). A fallback surrogate must be defined with the variable SMK_DEFAULT_SRGRID. This surrogate must contain all of the counties in our modeling domain and is usually set to the population surrogate. The SMK_USE_FALLBACK variable specifies whether to use the fallback surrogate when data is missing for a surrogate for a particular county.

Table 3. A sample SRGDESC file

```
#GRID US12NC_66X52 1128000.0 -672000.0 2000.0 12000.0 66 52 1 LAMBERT METERS 33.0 45.0 -97.0 -97.0 40.0
# Surrogate information for continental US 12-km grid
# Columns: Region, Code, Description, File
USA,100,Population,amgpro.12km_041604.nc.txt
USA,110,Housing,amgpro.12km_041604.nc.txt
USA,120,"Urban Population",amgpro.12km_041604.nc.txt
USA,130,"Rural Population",amgpro.12km_041604.nc.txt
USA,140,"Housing Change and Population",amgpro.12km_041604.nc.txt
USA,150,"Residential Heating - Natural Gas",amgpro.12km_041604.nc.txt
USA,160,"Residential Heating - Wood",amgpro.12km_041604.nc.txt
USA,170,"Residential Heating - Distillate Oil",amgpro.12km_041604.nc.txt
USA,180,"Residential Heating - Coal",amgpro.12km_041604.nc.txt
USA,190,"Residential Heating - LP Gas",amgpro.12km_041604.nc.txt
USA,200,"Urban Primary Road Miles",amgpro.12km_041604.nc.txt
USA,210,"Rural Primary Road Miles",amgpro.12km_041604.nc.txt
USA,220,"Urban Secondary Road Miles",amgpro.12km_041604.nc.txt
USA,230,"Rural Secondary Road Miles",amgpro.12km_041604.nc.txt
```

Support for Non-Sequential Temporal Processing

Previous versions of **Temporal** could only process a single continuous time period during each execution of the program and produce a single output file. This behavior becomes limiting in newer modeling applications where, for certain sectors, only a representative Monday, weekday, Saturday, and Sunday, plus any holidays are processed for each month. This type of processing can require complex scripting to run **Temporal** several times and is a source of processing errors. The updated version of **Temporal** can process a list of non-sequential processing dates during a single execution, which greatly simplifies scripting. A new input file called PROCDATES is used to indicate the time periods that **Temporal** should process. A sample PROCDATES file is shown below. In this case, we are processing the first day of each month of 2005. Twelve output files will be produced, each containing 25 time steps.

```
# 1st of each month for 2005
20050101 0 250000 ! January
20050201 0 250000 ! February
20050301 0 250000 ! March
20050401 0 250000 ! April
20050501 0 250000 ! May
20050601 0 250000 ! June
20050701 0 250000 ! July
20050801 0 250000 ! August
20050901 0 250000 ! September
20051001 0 250000 ! October
20051101 0 250000 ! November
20051201 0 250000 ! December
```

Revisions to Inventory Processing

The collection of updated ORL formats (e.g., point, nonpoint, nonroad, ...) is being used as the interface between the 2002 NEI and SMOKE. The ORL formats had been added to SMOKE previously in order to support toxics modeling. These formats are similar to the IDA formats, except that IDA files give information about all pollutants for a source on a single line, whereas ORL files provide data for a single pollutant on each line and the source characteristic information is repeated on multiple lines (i.e., one line for each pollutant emitted from the source). **Smkinven** was updated to be able to read an "extended ORL" format in addition to the older ORL format. The extended ORL format has additional fields that did not exist in previous versions of the ORL format. **Smkinven** was also updated to use 16

characters for the CAS code, also known as the pollutant code, to allow for all criteria pollutants to be input using the ORL format.

The new **Smkinven** accepts source type codes for area, nonroad mobile and onroad mobile sources, as well as ORIS and boiler identification codes for point sources. With addition of ORIS and boiler ID to point source ORL input files, **Smkinven** can now match hourly point source data to annual data in either IDA or ORL format. As matching hourly point data to annual data, SMOKE now allow for multiple plant descriptions and FIPS codes for a single ORIS ID. In addition, **Smkinven** now treats duplicate sources be treated as separate sources. This is so that hourly CEM data can match to sources that may be identical in their source characteristics but have different boiler IDs.

Updates to Growth and Control Processing

Several updates related to growth and control processing are included in SMOKE v2.3. First, **Cntlmat** accepts source type codes of 03 and 04 for nonroad and onroad mobile, respectively. Second, **Cntlmat** accepts twelve new cases in the projection packet for plant-specific source matching. The following twelve cases were added to the projection packet:

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

Third, **Grwinven** can output the correct control efficiency, rule effectiveness, and rule penetration values to the grown and/or controlled inventory. Since **Cntlmat** only stores the final multiplicative or growth factor in the control or growth matrix, this update required changes in **Cntlmat** so that the necessary values can be computed and stored.

New Treatment for Wildfires

The goal of this task is to update SMOKE to read and use day-specific 2002 NEI wildfire and prescribed burning emissions data in conjunction with the BlueSky Pouliot-Godowitch plume rise algorithm already included in SMOKE. In a previous work assignment, a preprocessor (**BlueSky2Inv**) was developed to convert fire emissions output files generated by the BlueSky CONSUME model into SMOKE-readable annual and daily inventories that include both the heat flux produced by wildfires and the area burned. The new approach consists of reading two separate inventory files provided in two new variants of the point ORL format.

The first new format, called #ORL FIRE, contains a list of fires with characteristics of each fire and is similar to an annual inventory file (Table 4). The characteristics include location, material burned, NFDRS code, and heat content. The second format, called #ORL FIREEMIS, contains day-specific fire data such as fuel loading, acres burned, begin and end hour, and emissions by pollutant, (Table 5). Instead of obtaining heat flux from the BlueSky preprocessor as was done previously, the heat flux is calculated from the fuel consumed and acres burned over the duration of the burn according to the equation [3]:

$$\text{Heat flux (BTU/day)} = \text{acres burned (acre/day)} * \text{fuel consumed (tons/acre)} * \text{heat content (BTU/lb)} * (2000 \text{ lb/ton}) \quad (3)$$

where 1 BTU/hr \approx 0.293 watts. Note that the heat content variable is from a mater #ORL FIRE file. The daily heat flux and emissions values are then temporally allocated to create hour-specific data by applying a diurnal temporal profile provided by the U.S. EPA. The temporal profile for the heat flux and fire emissions is adjusted if the fire is not burning for the entire day. In this case, the profile's shape will be preserved but it will be renormalized so 100% of the heat flux and emissions are retained and are distributed only between the beginning and ending hours reported in the daily fire data file. We expect this update to be included as a beta version in SMOKE v2.3.

Table 4. ORL FIRE format.

```
#ORL FIRE
#TYPE Point Source Inventory for FIRES
#COUNTRY US
#YEAR 2002
#DESC DAILY FIRES
```

Position in ORL file (column)	ORL variable name	Type in SMOKE	Description (for SMOKE documentation)
A	FIPS	Integer	Five digit FIPS code for state and county (required)
B	FIREID	Character(15)	ID for Fire
C	LOCID	Character(15)	String representing a unique location for a particular fire
D	FIRENAME	Character(40)	Name of fire
E	LAT	Real	Latitude associated with FIREID or FIREID/LOCID
F	LON	Real	Longitude associated with FIREID or FIREID/LOCID
G	FUELCONSUMED	Real	Tons of fuel per acre
H	NFDRSCODE	Character(2)	Code indicating type of area burned
I	MATBURNED	Integer	Code for the material burned

Table 5. ORL FIREEMIS format

```
#ORL FIREEMIS
#TYPE Point Source Inventory for FIRES
#COUNTRY US
#YEAR 2002
#DESC DAILY FIRES
```

Position in ORL file (column)	ORL variable name	Type in SMOKE	Description (for SMOKE documentation)
A	FIPS	Integer	Five digit FIPS code for state and county (required)
B	FIREID	Character(15)	ID for FIRE
C	LOCID	Character(15)	String representing a unique location for a particular fire
D	DATA	Character(16)	The pollutant code, "ACRESBURNED", "HFLUX", OR pollutants
E	DATE	Character(8)	Mm/dd/yy

F	DATAVALUE	Real	If the value of "DATA" is a particular pollutant, then this value represents the daily emissions associated with the particular pollutant
G	SCC	Character(10)	Flaming or smoldering
H	BEGHOUR	Integer	Hour of the day that the fire began (0 to 23).
I	ENDHOUR	Integer	Hour of the day that the fire ended (0 to 23).

Other Updates

Additional updates made in SMOKE 2.3 include the updating of the default Assigns file to use the new PROCDATES, SRGDESC and SRGPRO_PATH variables for the updated temporal processing and gridding. In addition, new variables were added to help control the naming of the output files from **Temporal**. Some new variables were also added to the scripts to control the use of the fallback surrogate, such as SMK_USE_FALLBACK and SMK_DEFAULT_SRGID.

POTENTIAL FUTURE UPDATES

There are a number of updates to SMOKE that have been discussed but have not yet been started. Whether and when these updates are implemented will be determined according to EPA's priorities. Possible updates include the following:

1. A new program called **Aermerge** will create output files suitable for input to AERMOD, and some minor updates to Smkinven and Smkreport will be included in this effort. Other updates may include support for ASPEN and/or ISCST. This work may be started on FY06, but is planned for completion in FY07 and is described further in the paper entitled "Updating SMOKE to Create AERMOD-ready Inputs for Urban-scale Air Dispersion Modeling" presented at this conference (Mason *et al.*, 2005).
2. Update **Smkreport** (and possibly **Smkmerge**) to create correct reports when an inventory pollutant has the same name as a model species that comes from a different inventory pollutant. For example, HG New AERMOD/ISCST Support HGIIGAS is an inventory pollutant and also a model species that comes from HGSUM.
3. The VOC-to-TOG factors are used to convert VOC emissions to TOG emissions so that the TOG emissions can be speciated using the speciation profiles (which are typically based on TOG emissions). Currently, the factors are assigned by SCC and are matched to the inventory sources. In this update, the VOC-to-TOG factors will be matched to the speciation profiles and not directly to the sources.
4. Add options to **Smkreport** to include profile descriptions when reporting temporal, speciation, and gridding profile information. This update will require adding new profile description fields to the temporal profiles and speciation profiles input files and storing these profile descriptions in the supplemental reporting files created by **Temporal** and **Spcmat**. With the addition of the surrogate description file needed for **Grdmat**, descriptions of the gridding surrogates will also be available.
5. Currently, processing non-sequential episode dates in a single execution is only limited to **Temporal** by using PROCDATES file which lists all non-sequential processing dates. In this update, all programs in SMOKE can share PROCDATES file for the non-sequential dates processing in one single execution.

6. Add the ability to compute monthly totals for specific months to **Smkreport**. The monthly total would be calculated by multiplying the average-day emissions value by the number of days in the month.

CONCLUSIONS

Recent updates to SMOKE v2.2 and v2.3 deliver many improvements to the emissions modeling capabilities, including the further integration of toxics and criteria processing and the integration of SMOKE with the EMF and the one-model framework. In SMOKE v2.2, the integration of SMOKE with the Blue Sky fire emissions estimates model, improved various grid resolution processing, and support of outputs for various toxics models were introduced. Better memory usage for gridding, user-friendly non-sequential multiple episodes modeling, the enhanced extended ORL format support, and possible wildfires inventory support are expected in SMOKE v2.3 release in 2006. Additional updates in support of EPA's one-model framework will be implemented according to EPA's priorities in FY 2006 and FY 2007.

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KEY WORDS

Emissions Modeling Framework
Emission Inventory
SMOKE