

Recent Updates to SMOKE

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Overview of Recent SMOKE Updates

- **EPA's OAQPS is developing the one-model framework for toxics and criteria modeling for all air quality models.**
- **Emission Modeling Framework (EMF)**
 - **Better management and tracking of data used for emissions modeling and for inputs**
 - **Settings used to prepare emissions data input to air quality models.**
- **SMOKE has been enhanced to facilitate the further integration of toxics and criteria processing**

Overview of Recent SMOKE Updates

- ④ **SMOKE v2.2 released in Fall 2005**
- ④ **SMOKE v2.3 is under development and scheduled for release in Summer 2006**

Summary of SMOKE v2.2 Updates

- ④ **BlueSky Integration**
- ④ **New Fire-specific Plume Rise**
- ④ **Revised CEM Approach**
- ④ **Better CAMx Support**
- ④ **Improved MOBILE6 Mapping**
- ④ **Updated Test Case**

SMOKE v2.2 Updates

BlueSky Integration

- BlueSky uses CONSUME to predict emissions from fires.
- New utility Program **BlueSky2Inv** converts BlueSky Output to SMOKE inventory
- Uses IDA formatted fire event inventory
- Creates Day-specific emissions inventory

SMOKE v2.2 Updates

BlueSky Integration Example Inventory

```
#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, PM_{2.5}, 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
```

SMOKE v2.2 Updates

🌐 New Fire-specific Plume Rise

- Retains traditional Briggs plume rise algorithm
- New BlueSky Pouliot-Godowitch fire-specific plume rise calculation

$$BEsize = 0.0703 * \ln(Acres) + 0.3$$

$$S fract = 1 - BEsize$$

$$BEsize = \text{Buoyant Efficiency}(m^4/s^3)$$

$$Acres = \text{Fire Size in acres}$$

SMOKE v2.2 Updates

Better CAMx Support

- New utility **Mrgelev** merges ASCII elevated files created by **Smkmerge**.
- Matching PinG sources from different input.
- Using PELV output by **Elevpoint**.
- **Mrgelev** can output binary PTSOURCE file for CAMx, REMSAD, and UAM.

SMOKE v2.2 Updates

🌐 Revised CEM Approach

- New CEM format provides mass emissions
- **CEMScan** reads a year worth of CEM data and calculates summed annual NO_x, SO₂, gross load, steam load and heat input.
- Output is read by **Smkinven** for temporal variation of emissions to calculate hourly emissions for all inventory pollutants
- Hourly Emissions = Annual emissions x
(Hourly heat Input/Annual heat Input)

SMOKE v2.2 Updates

Improved MOBILE6 Mapping

- Previously, MOBILE6 28 vehicle types mapped to 8 types in SMOKE.
- Enhanced integration of MOBILE6 with SMOKE: Custom mapping option is available from vehicle types to inventory types

SMOKE v2.2 Updates

Improved Reporting

- **Support for reporting by SCC level**
 - **BY SCC [1...4] [NAME] or BY SCC10 [NAME]**
- **New BY Instructions**
 - **BY MACT [NAME] : BY NAICS [NAME]**
 - **BY SRCTYPE [NAME]**
- **Print Latitude and Longitude coordinates for point sources**
 - **BY SOURCE [LATLONG]**
- **New /SET LABEL/ <label>**
 - **/SET LABEL/ NonEGUPoint (200 Characters) or OFF**
 - **/SET LABEL/ \$RUN_ID**

SMOKE v2.2 Updates

New Test Cases

- **1996 NEI and 1999 NTI**
 - **12km x 12km, North Carolina (nctox)**
 - **Many updated or new data files**
 - Temporal Allocation, Spatial Allocation, Chemical Speciation Files
 - Growth and Controls Files:
 - Mobile Source-Specific Files:
 - Other Support Files: MACTDESC, NAICSDESC, SCCDESC
 - Smkreport Input Files
- **NOTE:** these are intended to be sample files and should **NOT** be used for any modeling applications.

Summary of SMOKE v2.3 Updates

- **Memory Reduction for Gridding**
- **Non-sequential Temporal Processing**
- **Revised Inventory Processing**
- **Revised Control Processing**
- **Revised Growth Processing**
- **New ORL Fire Formats**

SMOKE v2.3 Updates

Memory Reduction for Gridding

- Previous **Grdmat** approach requires large amount of memory as the number of surrogate codes and grid cells increase.
- Instead, process only the assigned surrogate codes one at a time.
- Use surrogates either from a single file or multiple files.
- Some increase on computational time
- 90% reduction on memory usage.
- Note: [A|M|]GPRO are no longer in use.
SMK_DEFAULT_SRGRID = 100 (population) : default

SMOKE v2.3 Updates

New 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
```

SMOKE v2.3 Updates

🕒 Non-sequential Temporal Processing

- Previous **Temporal** approach can process a single continuous time period during each execution (Optional)
- Limits applications when only a representative days plus holidays are needed
- New Processing Dates File : **PROCDATES**

```
# 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
```

SMOKE v2.3 Updates

Revised Inventory Processing

- **Sminven** reads the new extended ORL formats and older ORL formats.
- Read Source Type, ORIS and boiler identification codes for point sources.
- Matches hourly point source data to annual data in either IDA or ORL format.
- Allows multiple plant descriptions and FIPS codes for an ORIS ID when matching hourly point data to annual data.
- Treats duplicate sources with different Boiler IDs as separate sources.

SMOKE v2.3 Updates

Revised Control Processing

- **Cntlmat accepts source type codes of 03 and 04 for nonroad and onroad mobile respectively.**
- **Cntlmat accepts twelve new cases in the projection packet for plant-specific source matching.**

SMOKE v2.3 Updates

New Cases for Control Processing

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

SMOKE v2.3 Updates

• Revised Growth Processing

- Updated **Cntlmat** since **Cntlmat** only stores the final multiplicative or growth factor in the control or growth matrix.
- **Grwinven** can output the correct control efficiency, rule effectiveness, and rule penetration values to the grown and/or controlled inventory.

SMOKE v2.3 Updates

New ORL Wildfires Inventory

- Two new wildfire inventory files.

(1) A list of fires with fire-specific characteristics (#ORL FIRE)

: location, material burned, NFDRS code, heat content .

(2) Day-specific fire data (#ORL FIREEMIS)

: fuel loading, acres burned, emissions by pollutant, begin and end hour.

SMOKE v2.3 Updates

New ORL FIRE Inventory

```
#ORL FIRE
#TYPE Point Source Inventory for Fires
#COUNTRY US
#YEAR 2001
#DESC SAMPLE DATA SET BASED ON FL Dept of Forestry Data
#DESC Created by George Rouliot 3/16/2006
#DESC FIRE EVENTS FILE
#POLLUTANT CO NOX SO2 NH3 EM2_5 PM10 VOC FUEL_LOAD ACRESBURNED BKGHOUR ENGHOUR
#DESC fips      fireid      Locid  SCC      Fire name      Lat      Lon      NEDRSCODE  MATURNED  HEATCONTENT  VALUE
37358      2001-05-0206  -9     28100010F0  'Mallory Swamp flaming'  36.2358  -78.9508  0          -9        HEATCONTENT  8001
37358      2001-05-0206  -9     28100010S0  'Mallory Swamp smoldering'  36.0550  -79.1230  0          -9        HEATCONTENT  8002
```

SMOKE v2.3 Updates

New ORL FIREEMIS Inventory

(2) Day-specific fire inventory

#ORL FIREEMIS

#TYPE Point Source Inventory for Fires

#COUNTRY US

#YEAR 2001

#DESC Sample Data created by George Pouliot 3/16/2006

#DESC DAILY FIRE EMISSIONS FOR FIRE EVENTS

#POLLUTANT CO NOX SO2 NH3 PM2_5 PM10 VOC FUEL_LOAD ACRESBURNED BEGHOURL ENDHOURL

#DESC	FIPS	FIREID	LOCID	SCC	DATA	DATE	DATAVALUE	BEGHOURL	ENDHOURL
	37358	2001-05-0206	-9	28100010F0	ACRESBURNED	05/22/01	415	5	12
	37358	2001-05-0206	-9	28100010F0	FUEL_LOAD	05/22/01	6.61	5	12
	37358	2001-05-0206	-9	28100010F0	PM2_5	05/22/01	27.41	5	12
	37358	2001-05-0206	-9	28100010F0	PM10	05/22/01	31.93	5	12
	37358	2001-05-0206	-9	28100010F0	CO	05/22/01	328.61	5	12
	37358	2001-05-0206	-9	28100010F0	NOX	05/22/01	6.99	5	12
	37358	2001-05-0206	-9	28100010F0	VOC	05/22/01	15.48	5	12
	37358	2001-05-0206	-9	28100010F0	SO2	05/22/01	1.92	5	12
	37358	2001-05-0206	-9	28100010F0	NH3	05/22/01	1.51	5	12
	37358	2001-05-0206	-9	28100010S0	ACRESBURNED	05/22/01	1415	0	23
	37358	2001-05-0206	-9	28100010S0	FUEL_LOAD	05/22/01	23.60	0	23
	37358	2001-05-0206	-9	28100010S0	PM2_5	05/22/01	127.41	0	23
	37358	2001-05-0206	-9	28100010S0	PM10	05/22/01	131.93	0	23
	37358	2001-05-0206	-9	28100010S0	CO	05/22/01	1328.61	0	23
	37358	2001-05-0206	-9	28100010S0	NOX	05/22/01	16.99	0	23
	37358	2001-05-0206	-9	28100010S0	VOC	05/22/01	115.48	0	23
	37358	2001-05-0206	-9	28100010S0	SO2	05/22/01	11.92	0	23
	37358	2001-05-0206	-9	28100010S0	NH3	05/22/01	11.51	0	23

SMOKE v2.3 Updates

New ORL Wildfires Inventory

- SMOKE treats as a point source with day-specific data
- Internal computation of wildfire heat flux

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

Re-normalized temporal hourly factors.

Potential Future Updates

- ④ A new program **Aermerge** will create output files suitable for input to AERMOD.
- ④ All programs in SMOKE can share PROCDATES file for the non-sequential dates processing in one single execution.
- ④ **Smkreport** could create a monthly reports.
- ④ Update **Smkreport** to include profile descriptions when reporting temporal, speciation, and gridding profile information.

SMOKE Support

- **User's Manual**
<http://cf.unc.edu/cep/empd/products/smoke/version2.2/html/>
- **Download available at**
<http://www.cep.unc.edu/empd/products/smoke>
- **CMAS Help Desk**
(<http://www.cmascenter.org>)
- **Emissions modeling email list**
(emregional@listserv.unc.edu)
- <http://bugzilla.unc.edu>