

Updating SMOKE to Create AERMOD-ready Inputs for Urban- scale Air Dispersion Modeling

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Why AERMOD?

- ✦ Preferred air dispersion model of EPA reflecting state-of-the-science advances in planetary boundary layer (PBL) meteorology and science
- ✦ Can be used to estimate relative contributions of individual sources to receptor estimated ambient concentrations
- ✦ Allows for the estimation of the concentration impacts of potential control strategies without re-running models
- ✦ Relatively user-friendly and accommodates modifications with ease as science evolves
- ✦ Can produce estimated concentrations on many time scales, averaging techniques, or violations of user-defined threshold values

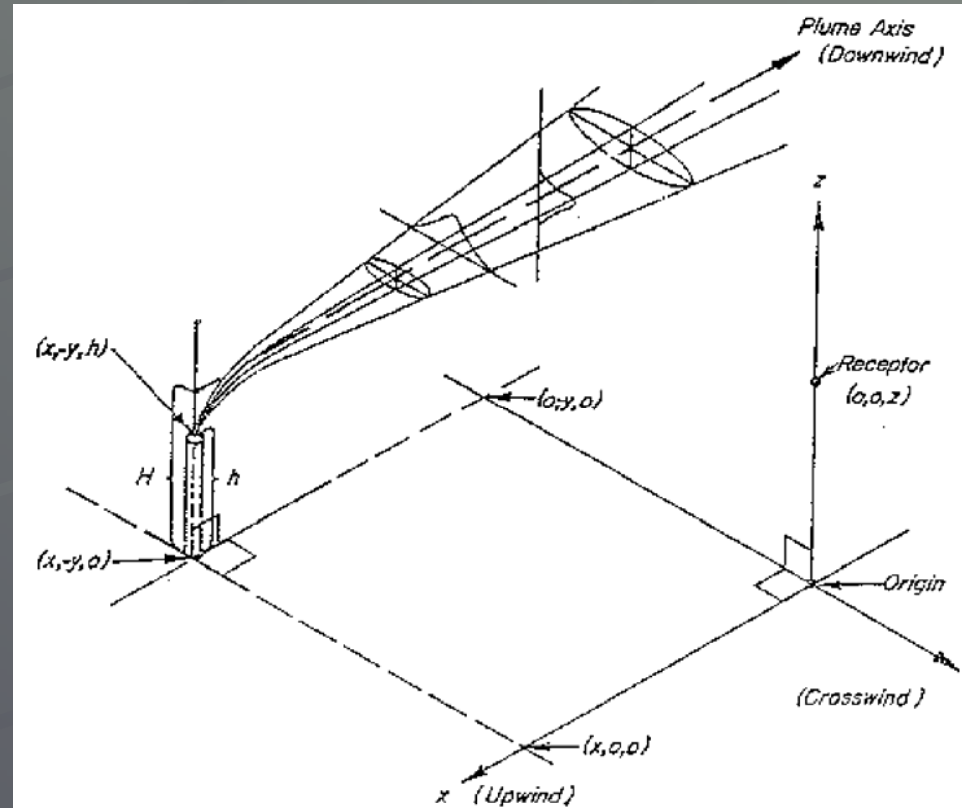
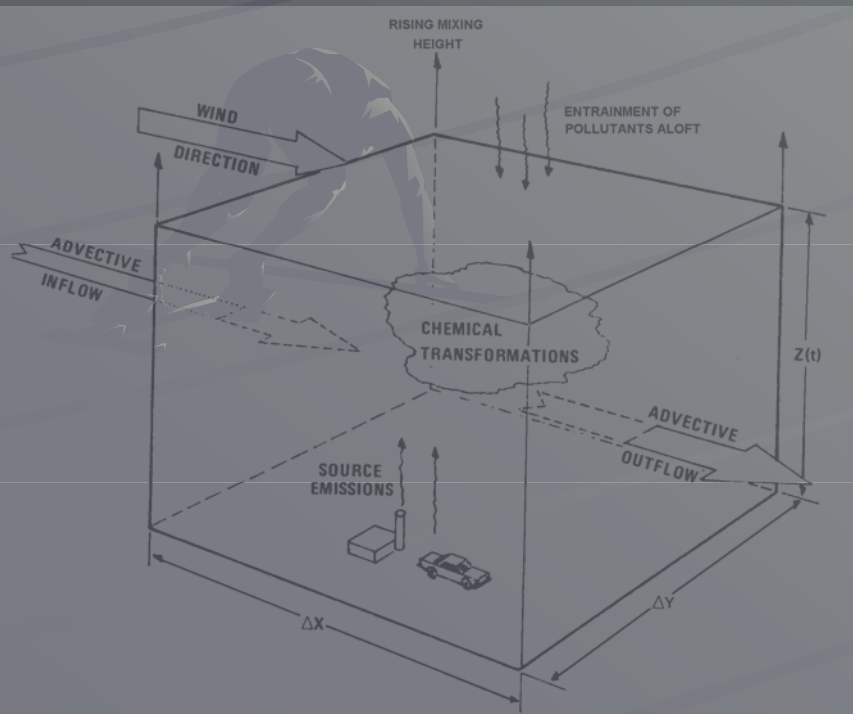
Why AERMOD? (cont.)

Photochemical Models (e.g. CMAQ)

large-scale models that account for chemical and physical atmospheric processes in predicting pollutant concentrations

AERMOD

source-oriented, characterizes atmospheric processes by dispersing a directly emitted pollutant to predict concentrations at selected downwind receptor locations



Why SMOKE?

- ✦ Already supports grid models currently used by EPA for many of the most recent rules and studies (e.g., CAIR, CAMR, CAVR, PM NAAQS)
- ✦ Supports multipollutant assessments, and all types of emissions sources



Why SMOKE? (cont.)

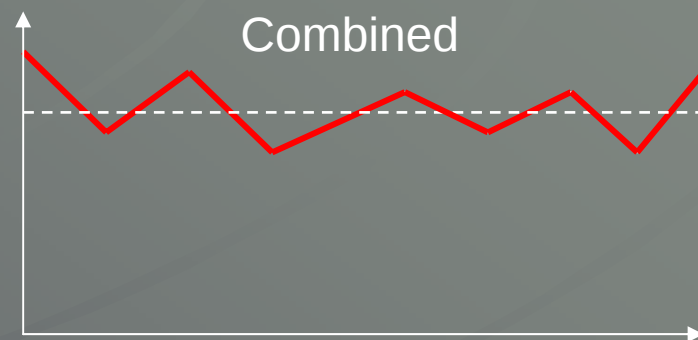
- ✦ Allows flexible future year scenarios based on available growth factors and control strategies
- ✦ A key tool in EPA's new Emission Modeling Framework and its associated data versioning and management, quality assurance (QA) protocols, and case management functions
- ✦ Non-proprietary
- ✦ Supports any chemical mechanism
- ✦ Supports multiple types of grids
- ✦ Computationally efficient
- ✦ Supports integrated use of Continuous Emissions Monitoring (CEM) data



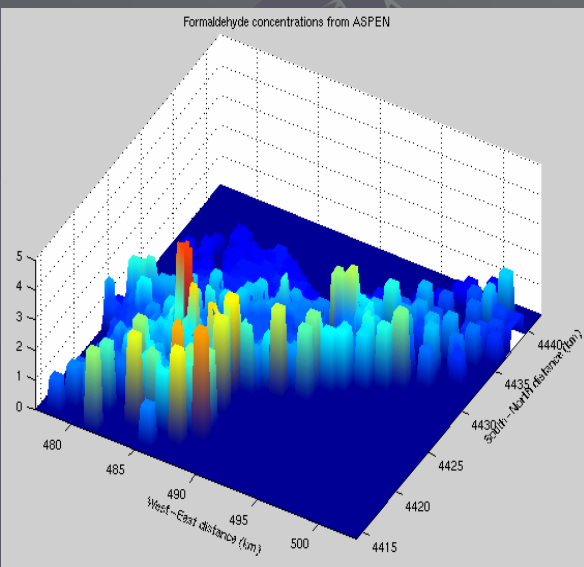
Benefits of a SMOKE-AERMOD Union

- ✦ Methodology and emissions processing data results in set of consistent emissions between grid and dispersion models
- ✦ Lead to a better understanding of the relationship between regional and local air quality modeling results
- ✦ Will facilitate continued development of hybrid approach that produces sub-grid spatial variability by combining CMAQ and AERMOD modeling results

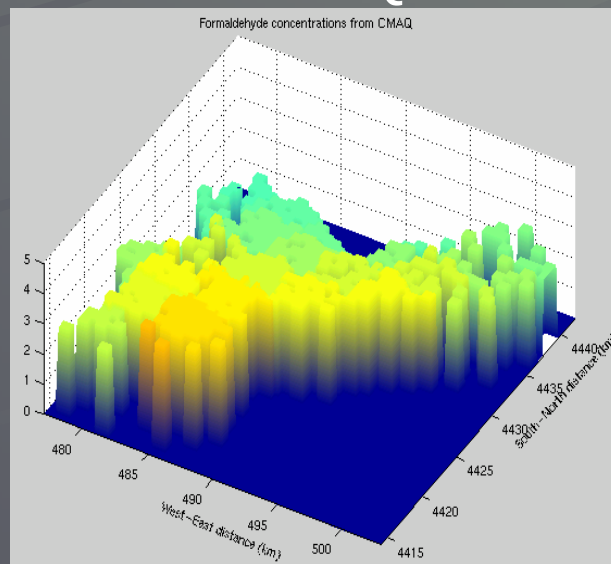
Benefits of a SMOKE-AERMOD Union (cont.)



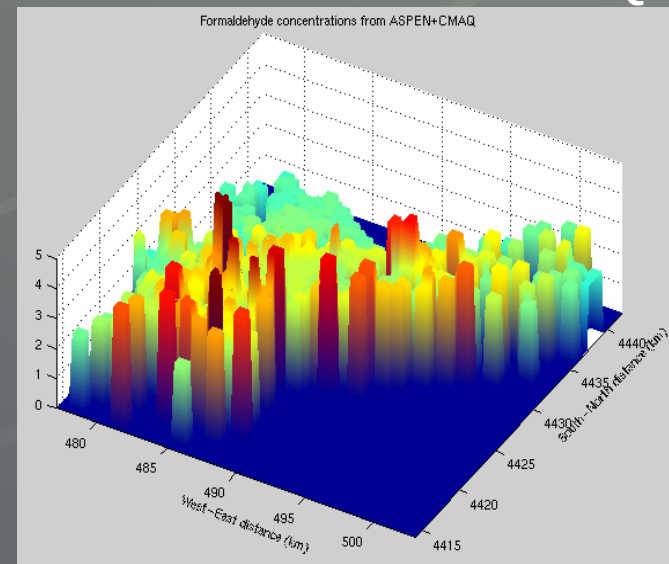
AERMOD



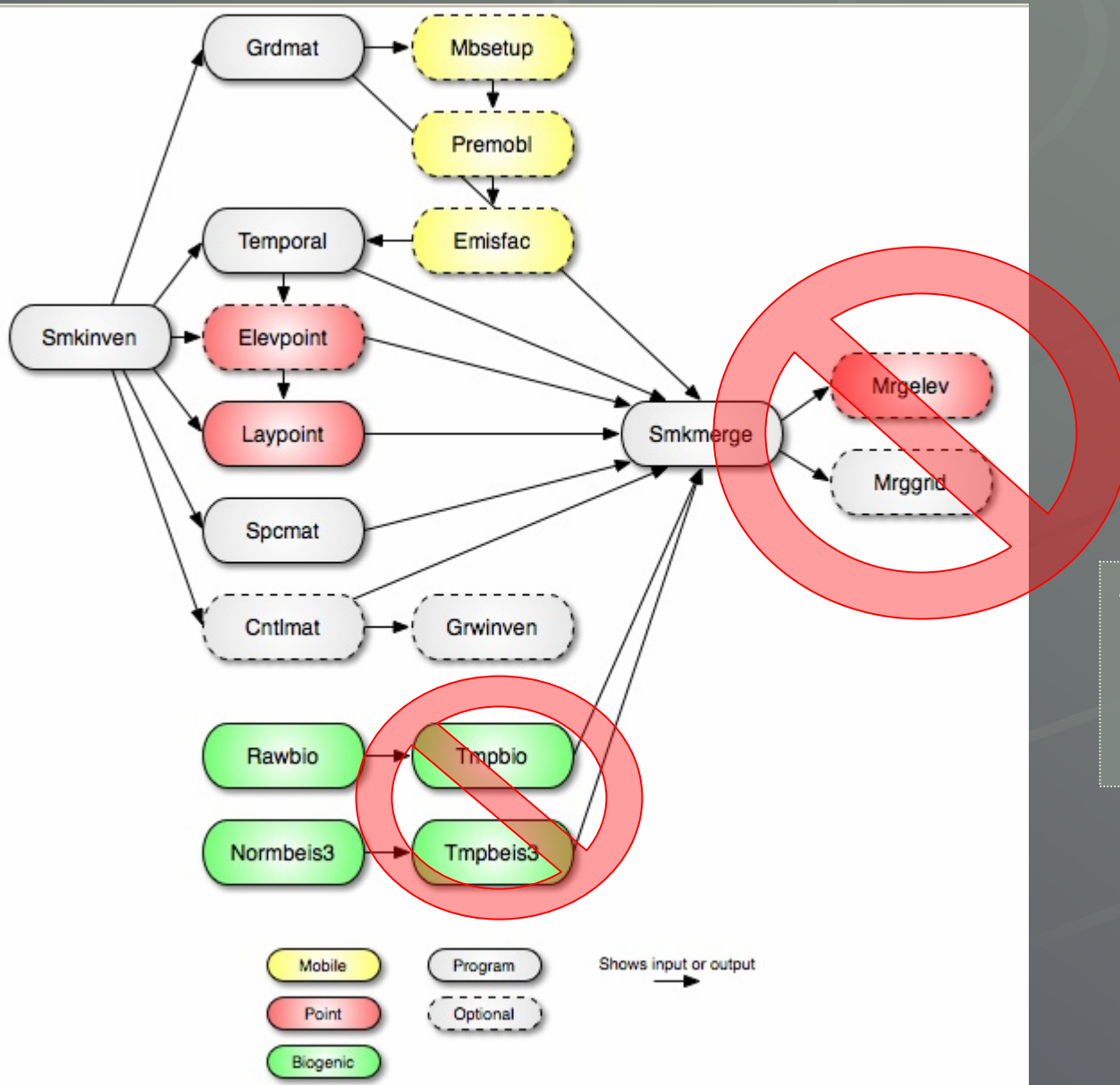
CMAQ



AERMOD+CMAQ

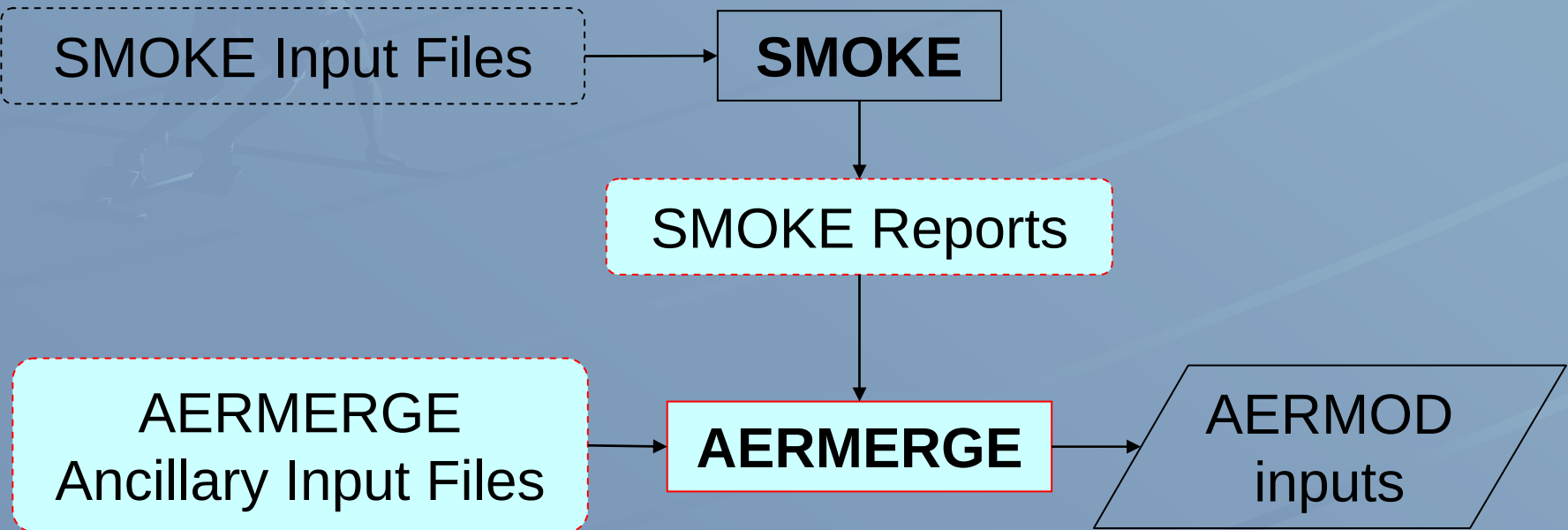
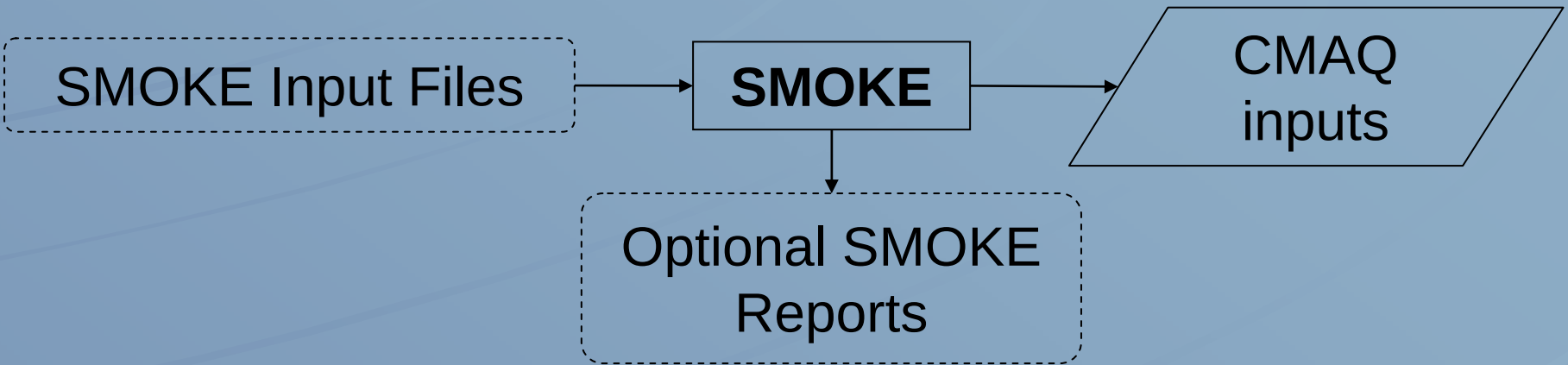


SMOKE Overview: Many Core programs unchanged for AERMOD processing



**** previously optional
SMKREPORT is
now essential**

Overall Program flow for SMOKE: CMAQ (top) and Proposed Program flow for AERMOD (bottom)



AERMOD Overview

- ✦ One directly-emitted pollutant per AERMOD model run
- ✦ Utilizes runstream input file structure with a keyword/parameter approach
- ✦ Consists of five functional pathways where each “command” line specifies model run options and input data

AERMOD Runstream Pathways

- ✦ **CO** - for specifying overall job **C**ontrol options
- ✦ **SO** - '.....' **S**ource (emissions-related) information
- ✦ **RE** - '.....' **R**Eceptor information
- ✦ **ME** - '.....' **M**eteorology information
- ✦ **OU** - '.....' **O**utput options

**** AERMOD-related updates for SMOKE primarily focus on the Source pathway section of the AERMOD runstream file**

AERMOD CO Pathway Example

CO STARTING

TITLEONE Draft Philadelphia 2002 sample emissions; Pollutant: **BENZENE**

TITLETWO tract surrogates dummy to 1km, and PHL airport

MODELOPT CONC TOXICS

AVERTIME 1 3 24 MONTH ANNUAL

URBANOPT 4500000 PHL 1

POLLUTID BENZ

HALFLIFE 1209600

GDSEASON 4 4 4 5 1 1 1 1 1 2 3 3

GDLANUSE 36*1

RUNORNOT RUN

ERRORFIL BENZ_ERR.OUT

SAVEFILE PHL_test_dump.sav1 1 PHL_test_dump.sav2

** INITFILE restart_MMDDYY.sav

CO FINISHED

AERMOD SO Pathway Example

```
SO STARTING
ELEVUNIT      METERS
CONCUNIT      1.0E6 GRAMS/SEC MICROGRAMS/M**3
DEPOUNIT      3.6E3 GRAMS/SEC GRAMS/M**2
** general AERMOD release parameters for area, point, volume, link-based, and gridded
sources
INCLUDED      /AERMOD INCLUDE files directory/area.BENZ
INCLUDED      /AERMOD INCLUDE files directory/pnt.BENZ
INCLUDED      /AERMOD INCLUDE files directory/vol.BENZ
INCLUDED      /AERMOD INCLUDE files directory/links.BENZ
INCLUDED      /AERMOD INCLUDE files directory/grid.BENZ
** file containing list of sources subject to urban dispersion
INCLUDED      /AERMOD INCLUDE files directory/urb_src.BENZ
** file containing building parameters for some AERMOD POINT sources
INCLUDED      /AERMOD INCLUDE files directory/bldg.BENZ
** file containing hourly emissions rates for all sources
INCLUDED      /AERMOD INCLUDE files directory/hrlyemis.BENZ
** file containing gas deposition parameters for all sources
INCLUDED      /AERMOD INCLUDE files directory/gasdepo.BENZ
** could also reference SRCGROUPs with an include file
SO SRCGROUP   CAT00    00P00001-00P99999
** In this example, there was another inventory sector "E" in source group "00"
SO SRCGROUP   CAT00    00E00001-00E99999
SO SRCGROUP   CAT02    02P00001-02P99999
SO SRCGROUP   CAT03    03I00001-03I99999
SO SRCGROUP   CAT77    77C00001-77C99999
SO SRCGROUP   CAT77    77F00001-77F99999
SO SRCGROUP   ALL
SO FINISHED
```

AERMOD RE and ME Pathways Example

RE STARTING

ELEVUNIT METERS

INCLUDED /receptor_file_directory/receptor file1.txt

INCLUDED /receptor_file_directory/receptor file2.txt

RE FINISHED

ME STARTING

SURFDATA 13739 2002

UAIRDATA 93734 2002

SURFFILE PHL04300-3.SFC

PROFFILE PHL04300-3.PFL

PROFBASE 50 METERS

STARTEND 02 01 01 02 12 31

ME FINISHED

AERMOD OU Pathway Example

OU STARTING

POSTFILE	1	ALL	PLOT	phI_BENZ_1_ALL.PST
POSTFILE	3	ALL	PLOT	phI_BENZ_3_ALL.PST
POSTFILE	24	CAT77	PLOT	phI_BENZ_24_77.PST
POSTFILE	24	ALL	PLOT	phI_BENZ_24_ALL.PST
POSTFILE	MONTH	CAT02	PLOT	phI_BENZ_MONTH_02.PST
POSTFILE	ANNUAL	CAT00	PLOT	phI_BENZ_ANNUAL_00.PST
POSTFILE	ANNUAL	CAT00	PLOT	phI_BENZ_ANNUAL_01.PST
POSTFILE	ANNUAL	CAT02	PLOT	phI_BENZ_ANNUAL_02.PST
POSTFILE	ANNUAL	CAT03	PLOT	phI_BENZ_ANNUAL_03.PST
POSTFILE	ANNUAL	CAT77	PLOT	phI_BENZ_ANNUAL_77.PST
POSTFILE	ANNUAL	ALL	PLOT	phI_BENZ_ANNUAL_ALL.PST

OU FINISHED

AERMOD Source Types

✦ POINT -stacks and isolated vents, uses all key inventory stack information



* * plume stack
temperature
never less than
ambient
temperature

* * AERMOD can
also model fixed
temperature
differential



AERMOD Source Types (cont.)

- ✚ VOLUME: releases from various industrial sources such as building roof monitors, multiple vents, and conveyer belts.
 - Used to model point source inventory emissions that are defined as horizontal stacks or fugitives, where stack parameters other than stack height are discarded



AERMOD Source Types (cont.)

- ✚ AREA: low or ground-level releases with no plume rise.
 - Used to model most non-point, onroad mobile, and nonroad mobile emissions



SMOKE Updates

🔧 SMKINVEN

- Allow county-level emissions allocated to point locations to retain identifiable ID that can be used to assign AERMOD release parameter information (e.g., assign airport dimensions for aircraft-related emissions that originate in the nonroad or non-point NEI files)

🔧 SMKREPORT

- Allow representative day(s) reports that retain more source-specific information such as MACT code and emission release point type

Create AERMERGE Module

- ✦ Replaces the core SMOKE program SMKMERGE
- ✦ Stand-alone module run after SMKREPORT has been run for all emission sectors
- ✦ Differs from SMKMERGE in 2 main areas:
 - Requires numerous AERMOD-specific input ancillary files
 - Outputs are ASCII and consist of one set of AERMOD input files for each directly-emitted pollutant, whereas SMKMERGE creates binary, typically hourly, gridded AQ input emissions containing all pollutants from all sectors

AERMERGE Operations

- ✦ Read in user-defined surrogate containing urban grid cell identification and create an AERMOD input file listing urban sources in these grid cells
- ✦ read in optional file that contains terrain heights from AERMAP and apply to emission sources based on lat/lon
- ✦ read in environment variables that will obtain grid domain, AERMOD model settings, and episode start and end dates which will also be used to parse the meteorology and emissions data into a format acceptable to AERMOD
- ✦ convert all emission source locations to relative UTM coordinates based on the AERMOD domain

AERMERGE Operations: Ancillary Input Files

- ✦ AERMOD runstream template containing COntrol, REceptor, and MEteorology pathways;
- ✦ SMKREPORT outputs and sector definitions;
- ✦ defines the AERMOD source groups and OUtput pathway averaging options for the concentration estimates;
- ✦ pollutant-specific COntrol pathway options containing abbreviations for file naming, and gas deposition parameters for gaseous pollutants;
- ✦ for particulate pollutants, particle deposition parameters applied by inventory sector and/or SCC;
- ✦ building dimensions for select AERMOD point sources, creates AERMOD input file containing acceptable sources and their corresponding building parameters;
- ✦ AERMOD source parameter definitions file used to assign default AERMOD source release parameters

Potential AERMERGE Environment Variables and Sample Values

Variable name	Example Value	Purpose / Description
GRID_NAME	PHL106x92km	Use SMOKE ancillary input file GRIDDESC to obtain size of grid, x/y of SW corner, UTM zone -consistent with SMOKE surrogates
EPI_SDATE	2002001	Episode start date (Julian), 01JAN2002 here
EPI_STIME	000000	Episode start time (HHMMSS), midnight here
EPI_RUNLEN	87600000	Episode run length (HHHHMMSS), 365 days here
AERMOD_SPECIES	BENZ, CR6, LEAD	Comma separated list of species names to extract from SMKREPORT files
AREADEFLT	2	AERMOD release height for AERMOD AREA sources
TERRHGTS	phl_terrain.txt	Optional file -terrain heights from AERMAP
USRCSURR	123	Urban source surrogate (number) used to define AERMOD sources subject to the increased surface heating from an urban area on pollutant dispersion under stable atmospheric conditions

Limitations for Initial Version

- ✦ User must be intimately familiar with the AERMOD system so as to craft an AERMOD runstream and associated INCLUDED files that will produce the expected AERMOD outputs
- ✦ Limited QA routines; AERMERGE will not ensure AERMOD run stream is 100% correct
- ✦ Limited building parameter and deposition options
- ✦ Limited spatial and temporal resolutions
 - No non-rectangular area sources (e.g., census tracts)
 - Continuous, hourly emissions only
- ✦ Link-based emissions may need to be derived outside the SMOKE/AERMERGE system

Schedule



Updated SMOKE code (SMKINVEN and SMKREPORT) for AERMOD	late 2006
Release beta version of AERMERGE for EPA testing	mid 2007
Public release of updated SMOKE and AERMERGE module	late 2007

Questions or Comments?





HUGE
When CLINTON said
• NOBODY DIED •
ASS BEERS
THE SIGN
TO GO

HUGE ASS BEERS

**OLD ORLEANS
BEER HOUSE**

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