

Source Apportionment Modeling Results and RMC Status report

Gail Tonnesen, Zion Wang, Mohammad Omary, Chao-Jung Chien, Yingqun Wang
University of California, Riverside

Zac Adelman
University of North Carolina

Ralph Morris, Gerry Mansell et al.
ENVIRON Corporation Int., Novato, CA

Topics

- Model versions, datasets, domains, CPU benchmarks.
- Description of PSAT set up.
- Schedule for Modeling Results.
- Sample Results for monthly averages.
- Comparison of CAMx/PSAT and CMAQ/TSSA.
- Results on webpage at:
<http://pah.cert.ucr.edu/aqm/308/cmaq.shtml#CAMxPlan02c>

CMAQ & CAMx Visibility Modeling

- National RPO 36-km grid
- Model performance evaluation (MPE) compares model results to ambient monitoring data (IMPROVE, NADP, CASTNet, STN, AQS), on the web for 2002 Base B.
- PSAT source apportionment is being completed for 2 cases:
 - Plan 2002 C
 - Base 2018 B

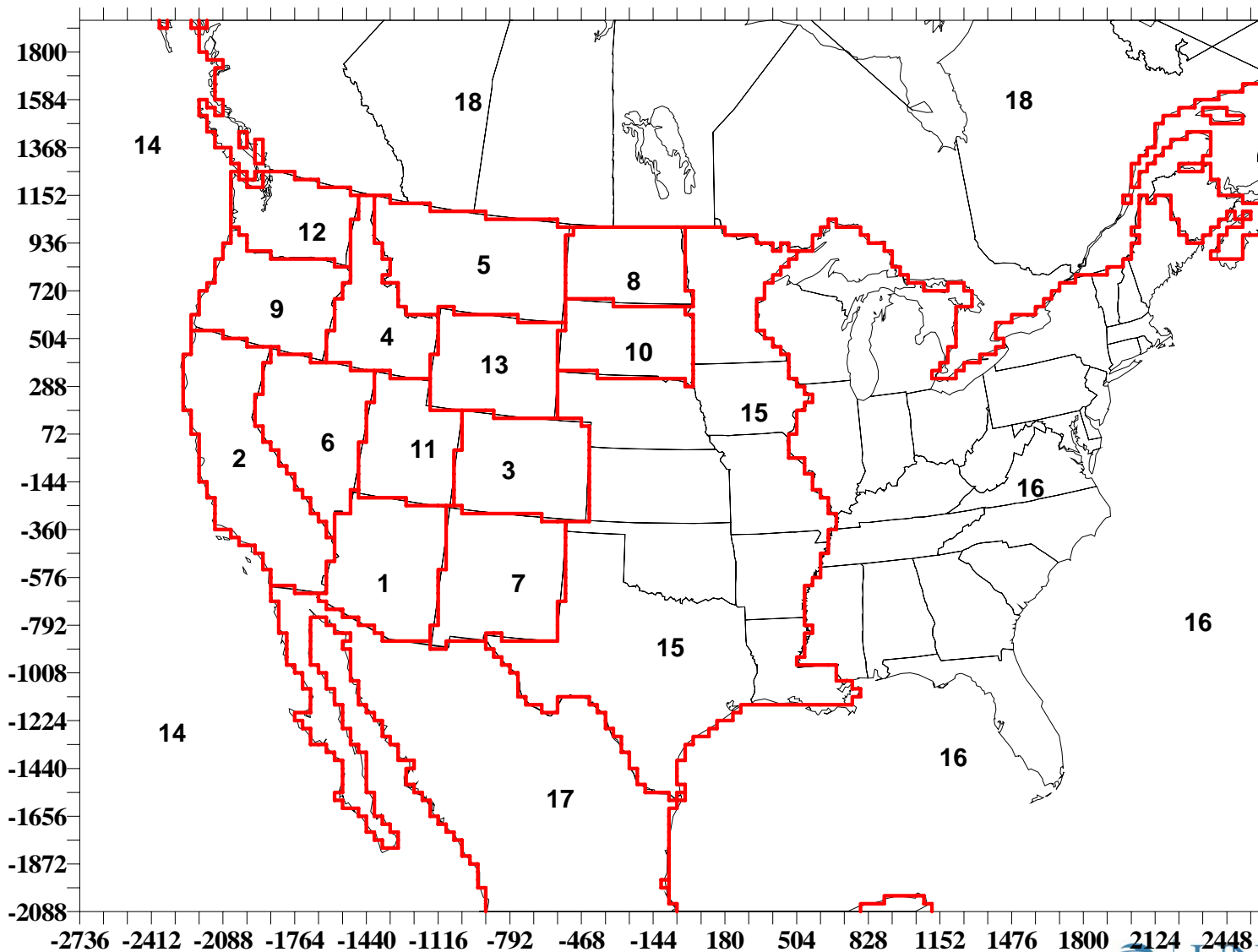
Air Quality Model Versions

- Using CAM_x with PSAT version 4.3
- Not using CMAQ/TSSA for WRAP, but we are testing CMAQ/TSSA on WRAP domain with EPA funding:
 - CMAQ/TSSA results are being compare to PSAT for QA.
 - previous CMAQ/TSSA was with CMAQ version 4.2 and 4.3, had problems with mass conservation errors.
 - current results are CMAQ 4.5 which includes new options for vertical advections with improved mass conservation.

PM Source Apportionment

- PM Source Apportionment Technology (PSAT).
- 2002 Plan C and 2018 Base C emissions.
- State Level Geographic Regions:
 - WRAP states, offshore, Canada, MX, CENRAP and Eastern US
- Track two families of PM Source Apportionment:
 - SO₄; NO₃ and NH₃/NH₄.
- For Secondary Organic Aerosols (SOA) use standard model output for anthropogenic and biogenic SOA
 - No geographic source apportionment for SOA or Primary PM.

WRAP PSAT 18 Source Regions



Geographic Source Region Codes

State Name	Source Code	Source Region ID
Arizona	AZ	1
California	CA	2
Colorado	CO	3
Idaho	ID	4
Montana	MT	5
Nevada	NV	6
New Mexico	NM	7
North Dakota	ND	8
Oregon	OR	9
South Dakota	SD	10
Utah	UT	11
Washington	WA	12
Wyoming	WY	13
Pacific Offshore & Sea of Cortez	OF	14
CENRAP States	CE	15
No-WRAP States	EA	16
Mexico	MX	17
Canada	CN	18

PSAT Emissions Source Group Codes

Table 6. WRAP PSAT emissions source groups

Emissions Source Groups	Low-level Sources	Elevated Sources
1	low-level point sources (including stationary off-shore)	elevated point sources (including stationary off-shore)
2	anthropogenic wild fires (WRAP only)	anthropogenic wild fires (WRAP only)
3	Total mobile (on-road, off-road, including planes, trains, ships in/near port, off-shore shipping)	
4	Natural emissions (natural fire, WRAP only, biogenics)	Natural emissions (natural fire, WRAP only, biogenics)
5	non-WRAP wild fires (Elevated fire sources in other RPOs)	non-WRAP wild fires (Elevated fire sources in other RPOs)
6	Everything else (area, all dust, fugitive ammonia, non-elevated fire sources in other RPOs)	

Emissions Source Group Codes in QA step

Traced Source Tags

Types	Source Category	Notes
ICON	ICON	Initial Concentration
BCON	BCON	Boundary Concentration
Emissions	MV_*	On/Off Road Mobile source of any state
	PT_*	Point Source of any state
	FW_*	Fire, Area, Road dust, biogenic, Wind Blow Dust, Ammonia, Fugitive Dust, Off-shore Area, Oil and Gas and Ammonia
	AR_*	Area Source of any state

- Note that the emissions groups above combine some PSAT source groups to allow comparison to CMAQ/TSSA for QA.
- Examples of emissions source-area groups:
 - PT_CO = point sources from Colorado
 - MV_EA = mobile sources from eastern US (MWRPO, VISTAS, MAIN-VU)
 - BCON = transport from boundaries (GEOS-CHEM)

Source Apportionment Modeling

- White paper describes issues associated with the CAMx PSAT modeling: www.cert.ucr.edu/aqm/308/docs

Table 1. Benchmarks for PSAT computational costs for each PM species. Run time is for one day (01/02/2002) of the WRAP 36-km domain.

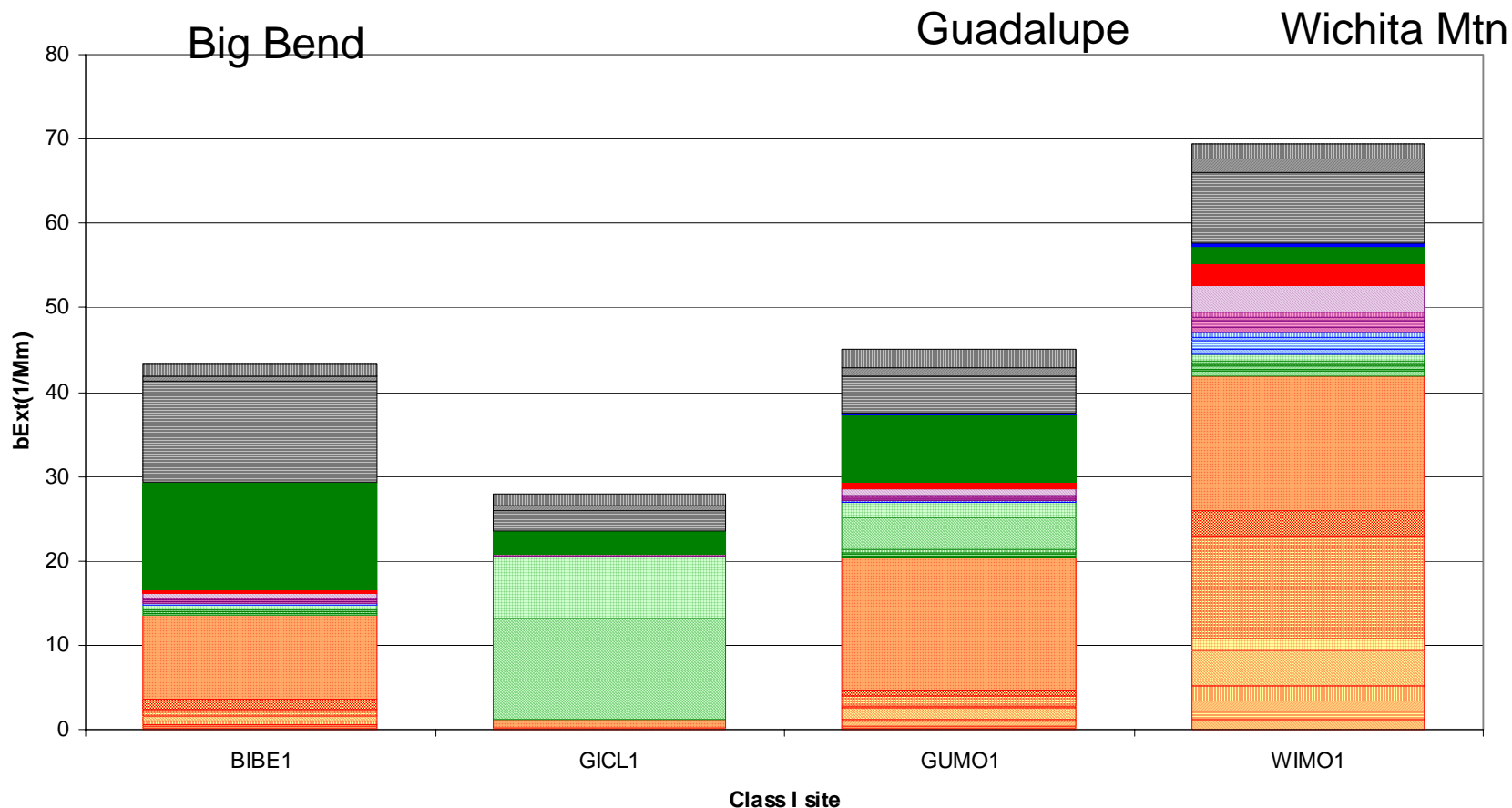
Species	Number of species Tracers	RAM Memory	Disk Storage per day	Run Time with 1 CPU no OMP	Run Time with 2 CPU OMP
SO4	2	1.6 GB	1.1 GB	4.7 hr/day	4 hr/day
NO3	7	1.7 GB	2.6 GB	13.2 hr/day	Not tested
SO4 & NO3 combined	9	1.9 GB	3.3 GB	16.8 hr/day	Not tested
SOA	14	6.8 GB	Not tested	Not tested	Not tested
Primary PM species	6	1.5 GB	3.0 GB	10.8 hr/day	Not tested

Analysis Products for PSAT

- Current results are daily and monthly averages for QA.
- When annual run is complete we will process SO₄ and NO₃ at each Class I area for W20% Days.
- Convert to Extinction (B_{ext}) and determine State's contribution to Worst 20% days for 2002 Plan C and 2018 B.

Example CENRAP Results for 4 Class I areas

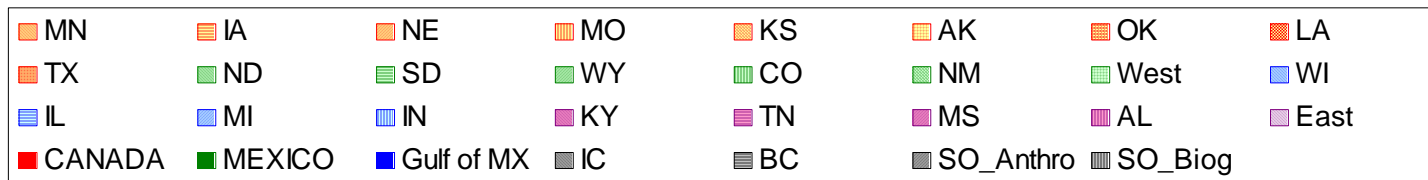
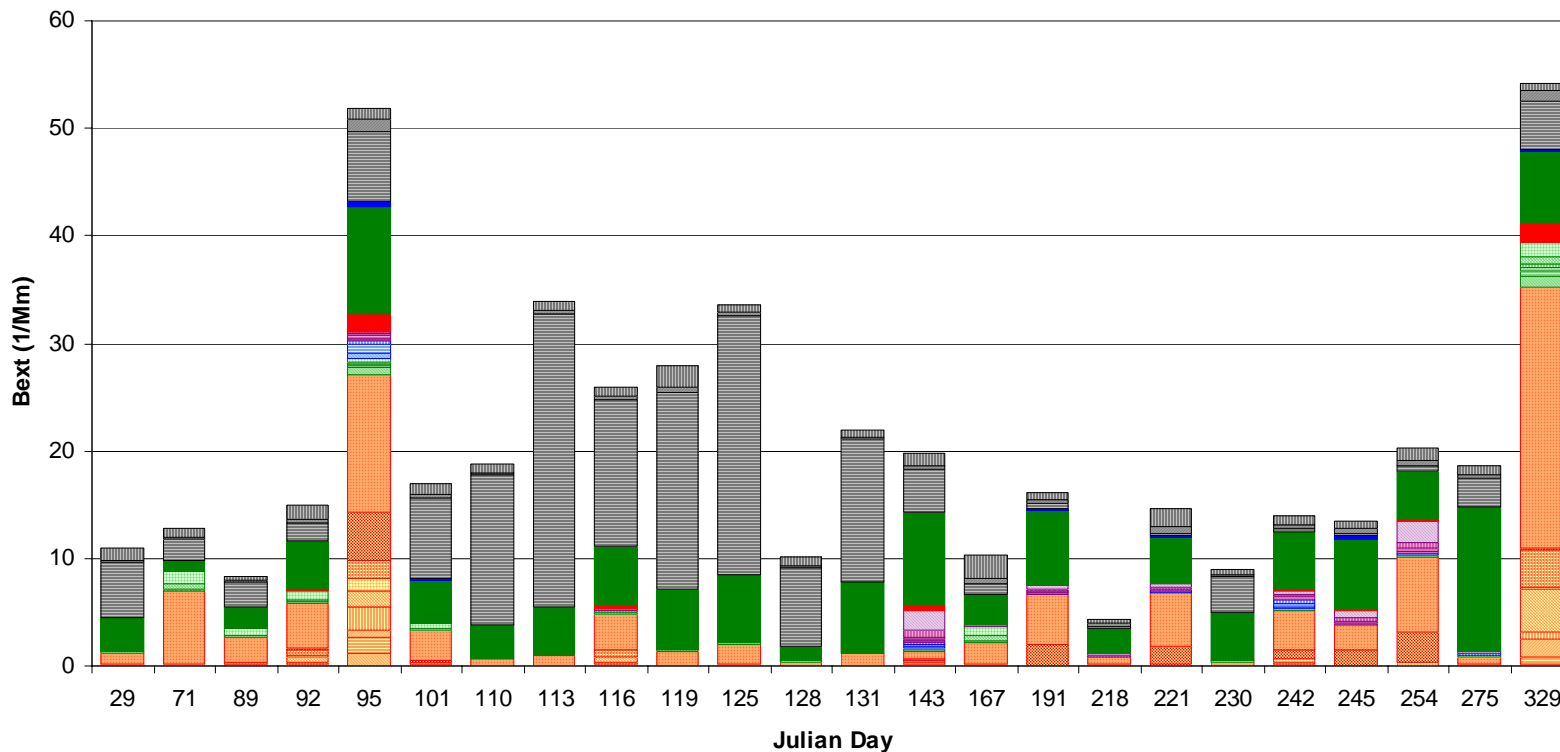
Projected 2018 extinction by States a& Regions (C1)



MN	IA	NE	MO	KS	AK	OK	LA	TX	ND	SD
WY	CO	NM	West	WI	IL	MI	IN	KY	TN	MS
AL	East	CANADA	MEXICO	Gulf of MX	IC	BC	SO_Anthro	SO_Biog		

Example CENRAP detailed results for a Class I area

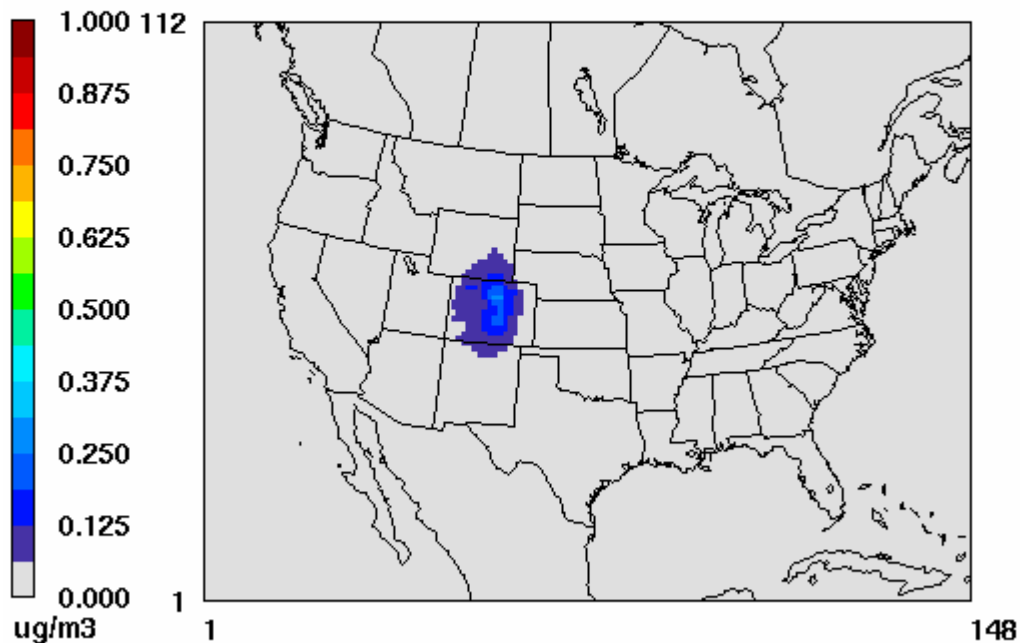
Worst 20% Model Day for BIBE1



PSAT July average Spatial Results

PSO4 Point Source CO

CAMx Planning 02c
Monthly Average: July

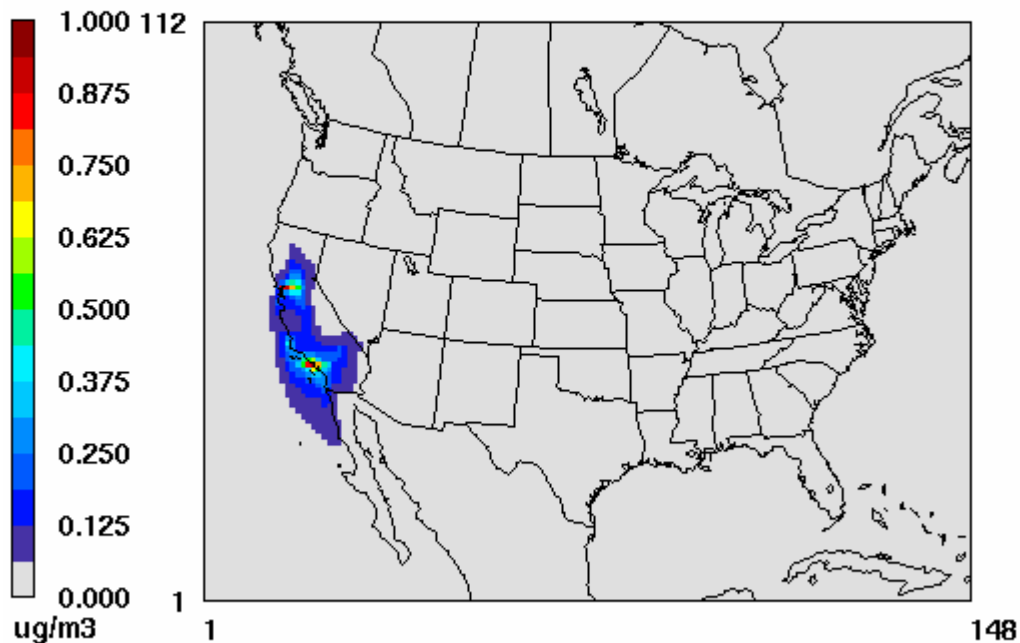


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 0.293 at (57,59)

PSAT July average Spatial Results

PSO4 Point Source CA

CAMx Planning 02c
Monthly Average: July

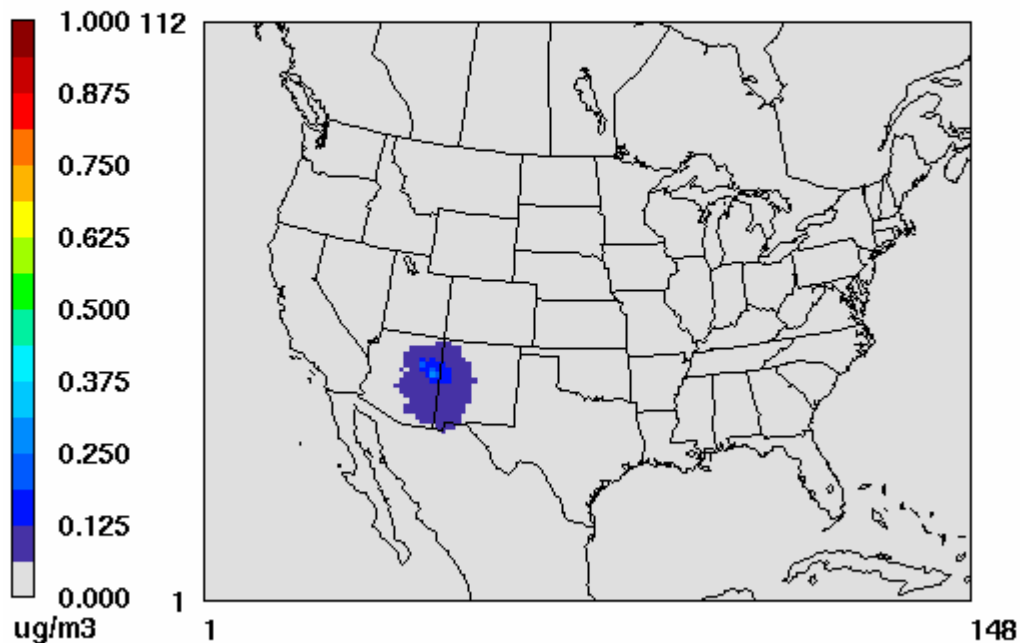


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 1.257 at (22,46)

PSAT July average Spatial Results

PSO4 Point Source AZ

CAMx Planning 02c
Monthly Average: July

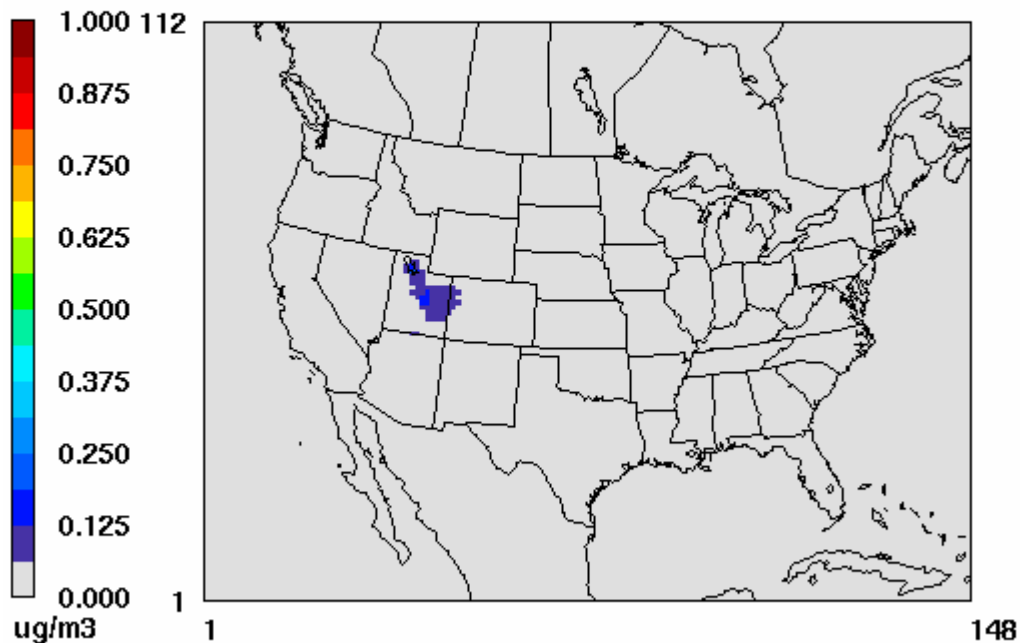


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 0.309 at (45,44)

PSAT July average Spatial Results

PSO4 Point Source UT

CAMx Planning 02c
Monthly Average: July

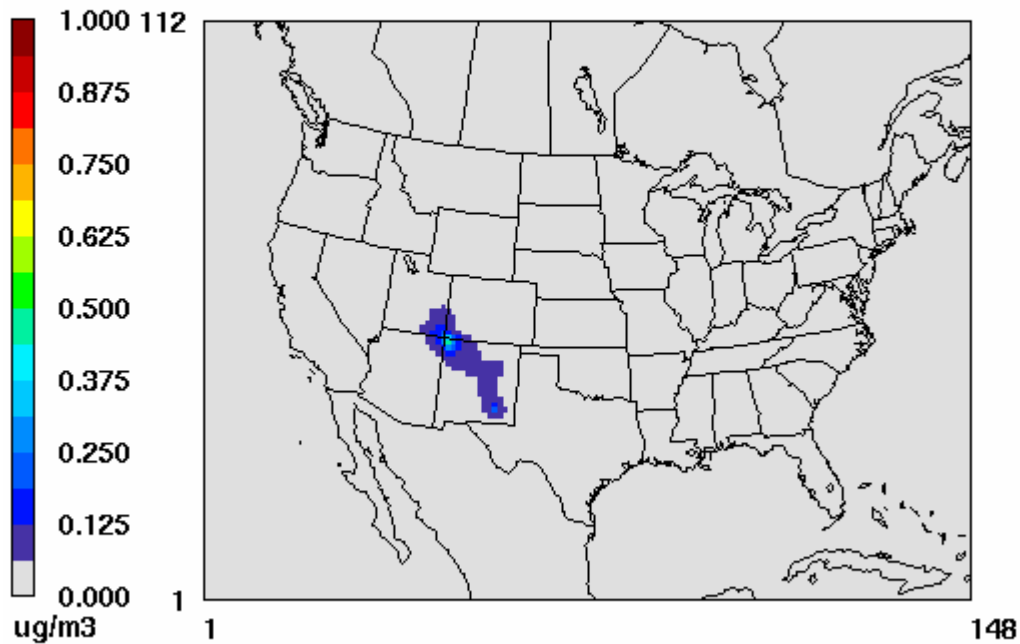


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 0.198 at (41,64)

PSAT July average Spatial Results

PSO4 Point Source NM

CAMx Planning 02c
Monthly Average: July

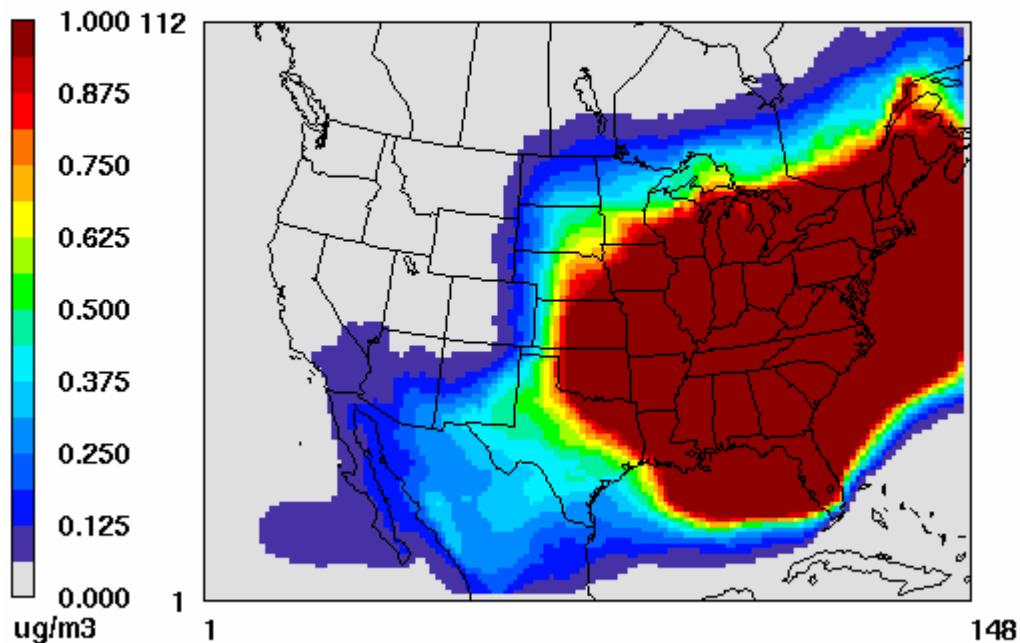


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 0.472 at (48,50)

PSAT July average Spatial Results

PSO4 Point Source Eastern

CAMx Planning 02c
Monthly Average: July

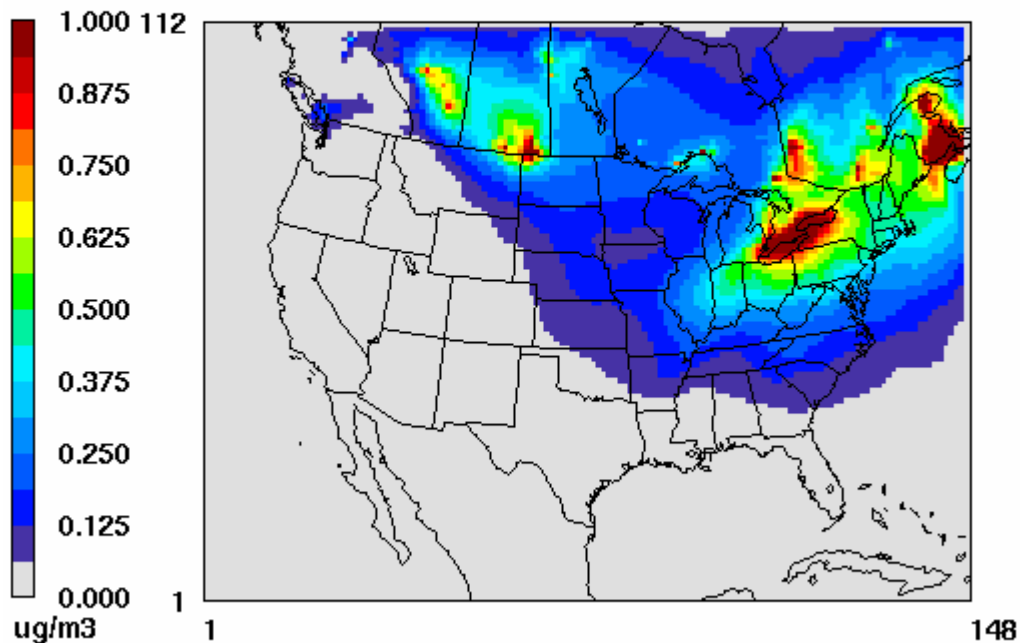


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 12.258 at (107,57)

PSAT July average Spatial Results

PSO4 Point Source Canada

CAMx Planning 02c
Monthly Average: July

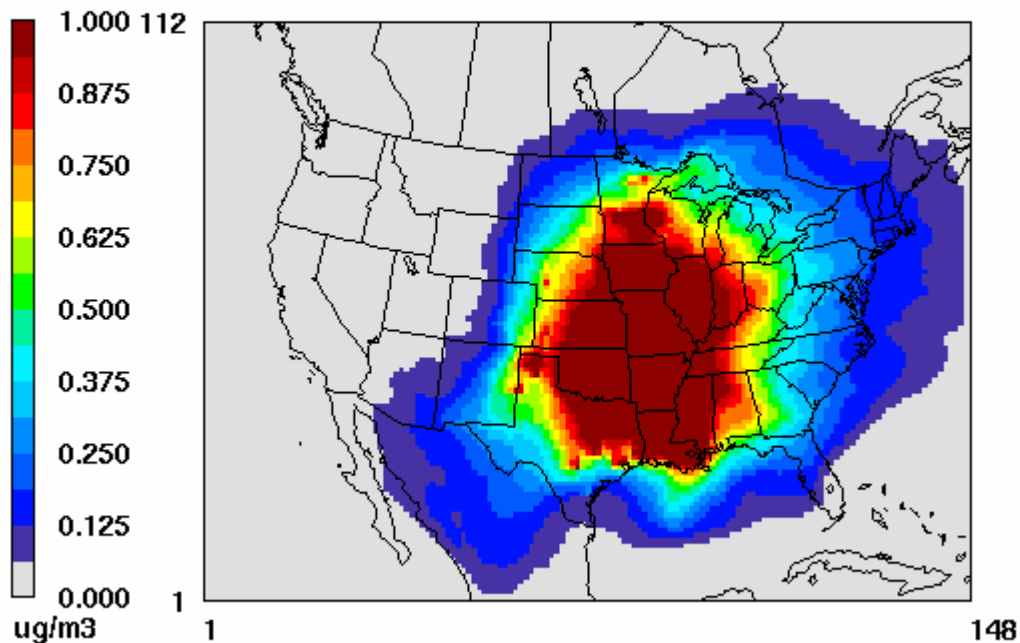


July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 4.065 at (143,86)

PSAT July average Spatial Results

PSO4 Point Source CENRAP

CAMx Planning 02c
Monthly Average: July



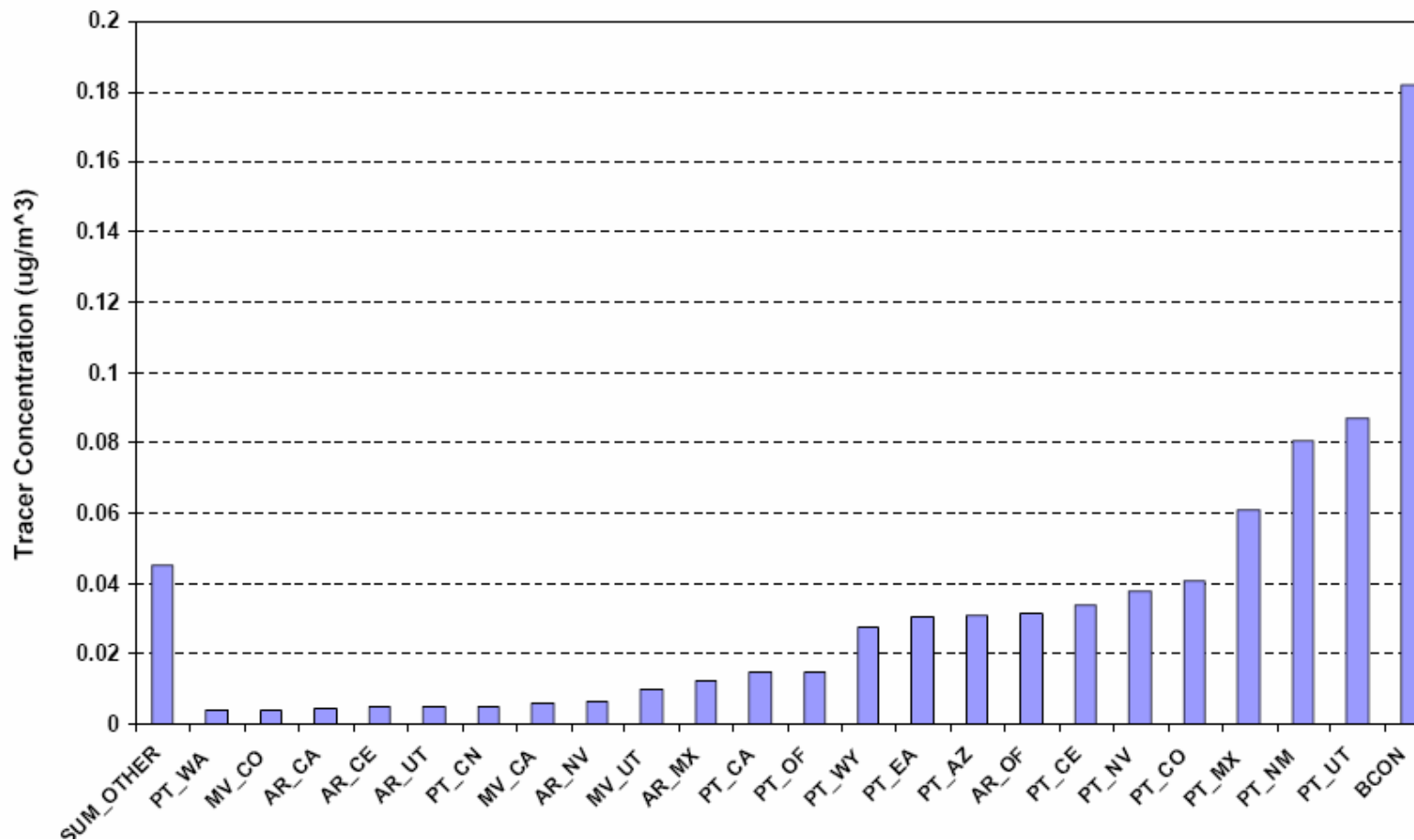
July 1, 2002 0:00:00
Min= 0.000 at (1,1), Max= 3.395 at (82,37)

PSAT

Canyonlands National Park, UT (CANY1)

WRAP Plan02c PSAT Tracers of PSO4: July

Sum of all TRACER Concentration = 0.8593



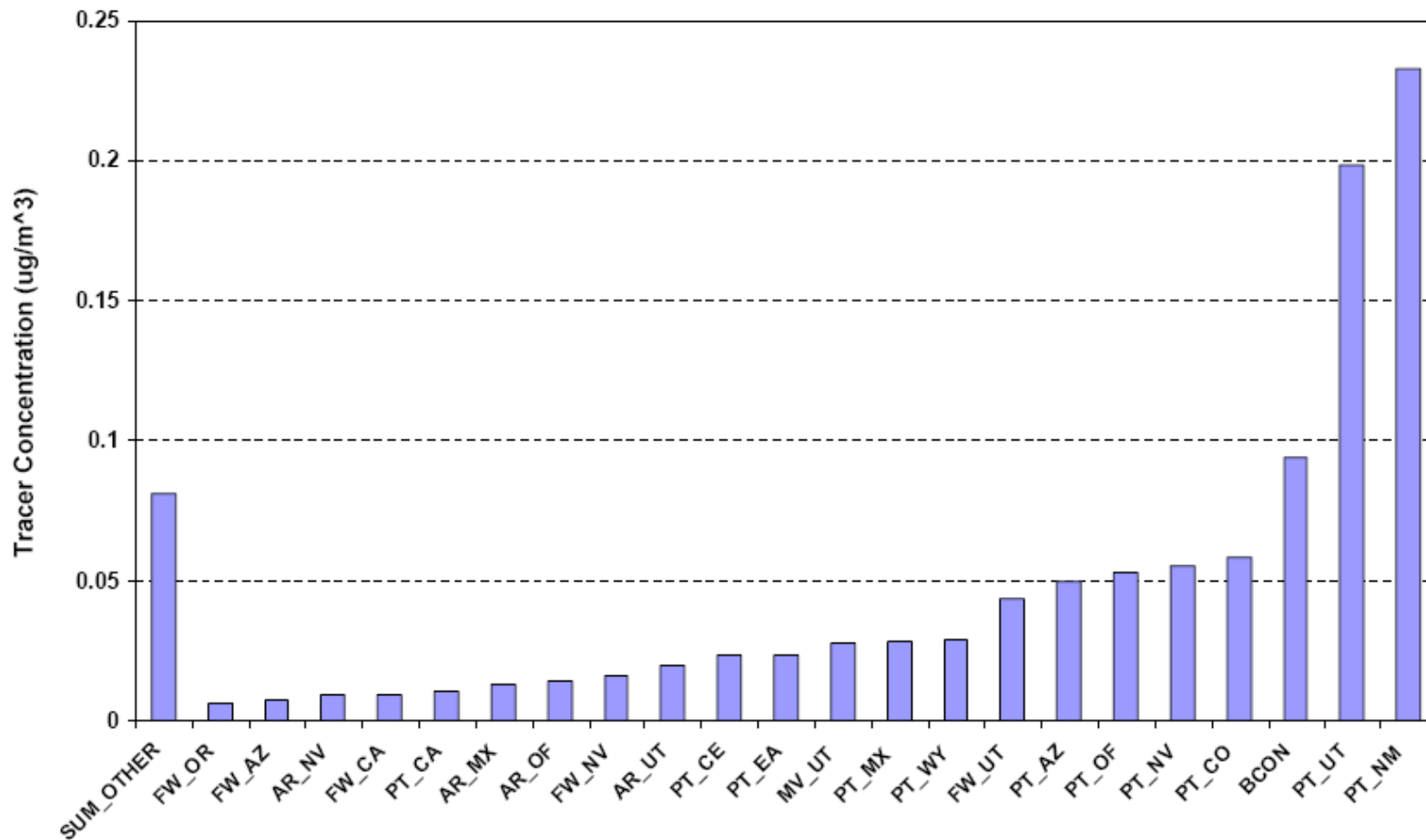
TSSA

Canyonlands National Park, UT (CANY1)

WRAP Plan02c TSSA Tracers of ASO4: July

Sum of all TRACER Concentration = 1.102

ACONC = 1.102



Summary of Ranked sources for Canyon Lands

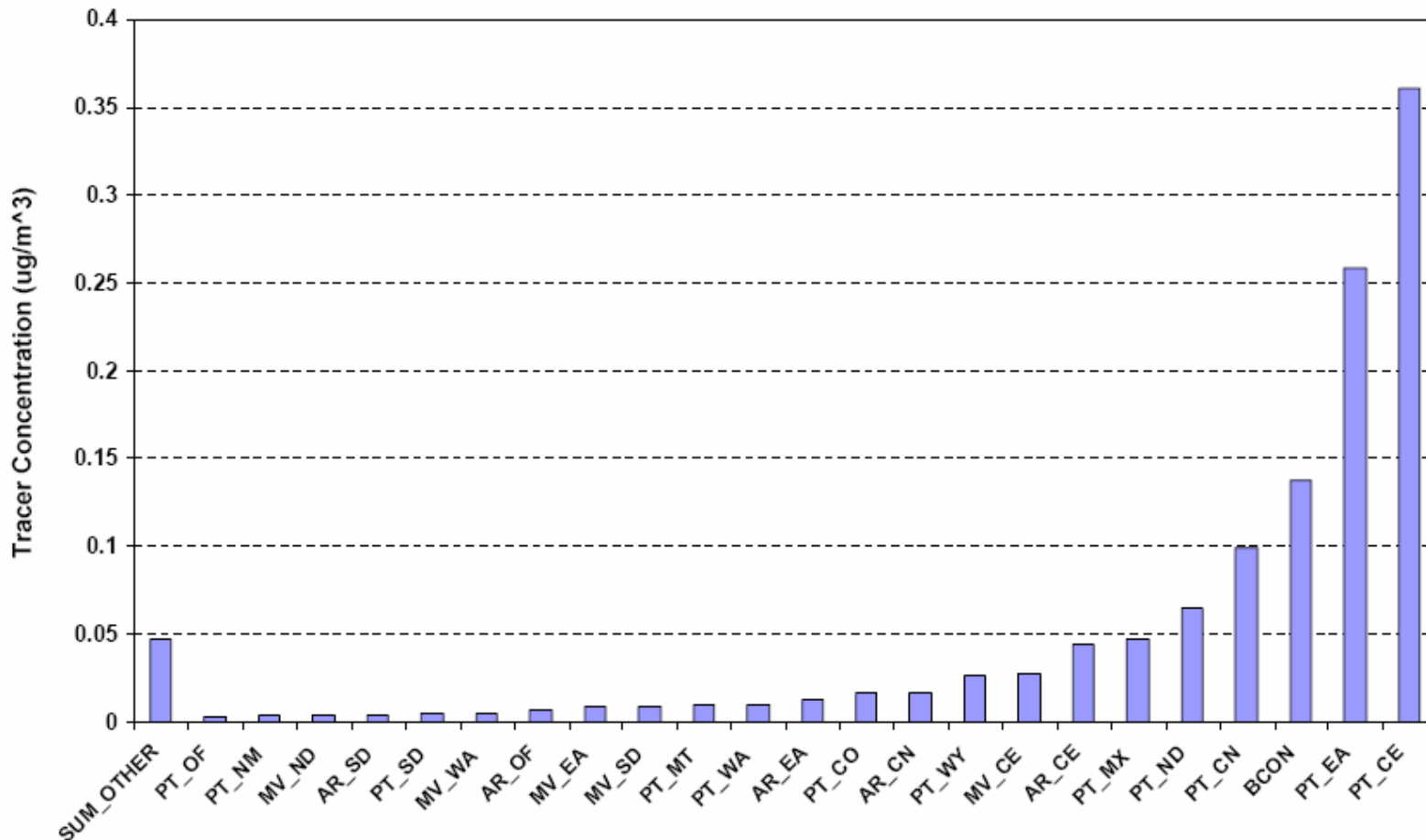
PSAT	TSSA
Boundaries Point UT Point NM Point Mexico Point CO Point NV Point CENRAP Area Offshore Point AZ Point eastern US Point Wyoming Point offshore Point CA	Point NM Point UT Boundaries Point CO Point NV Point offshore Point AZ Fires/Area/Etc UT Point Wyoming Point Mexico Mobile Utah Point Eastern US Point CENRAP

PSAT

Badlands National Park, SD (BADL1)

WRAP Plan02c PSAT Tracers of PSO4: July

Sum of all TRACER Concentration = 1.2483



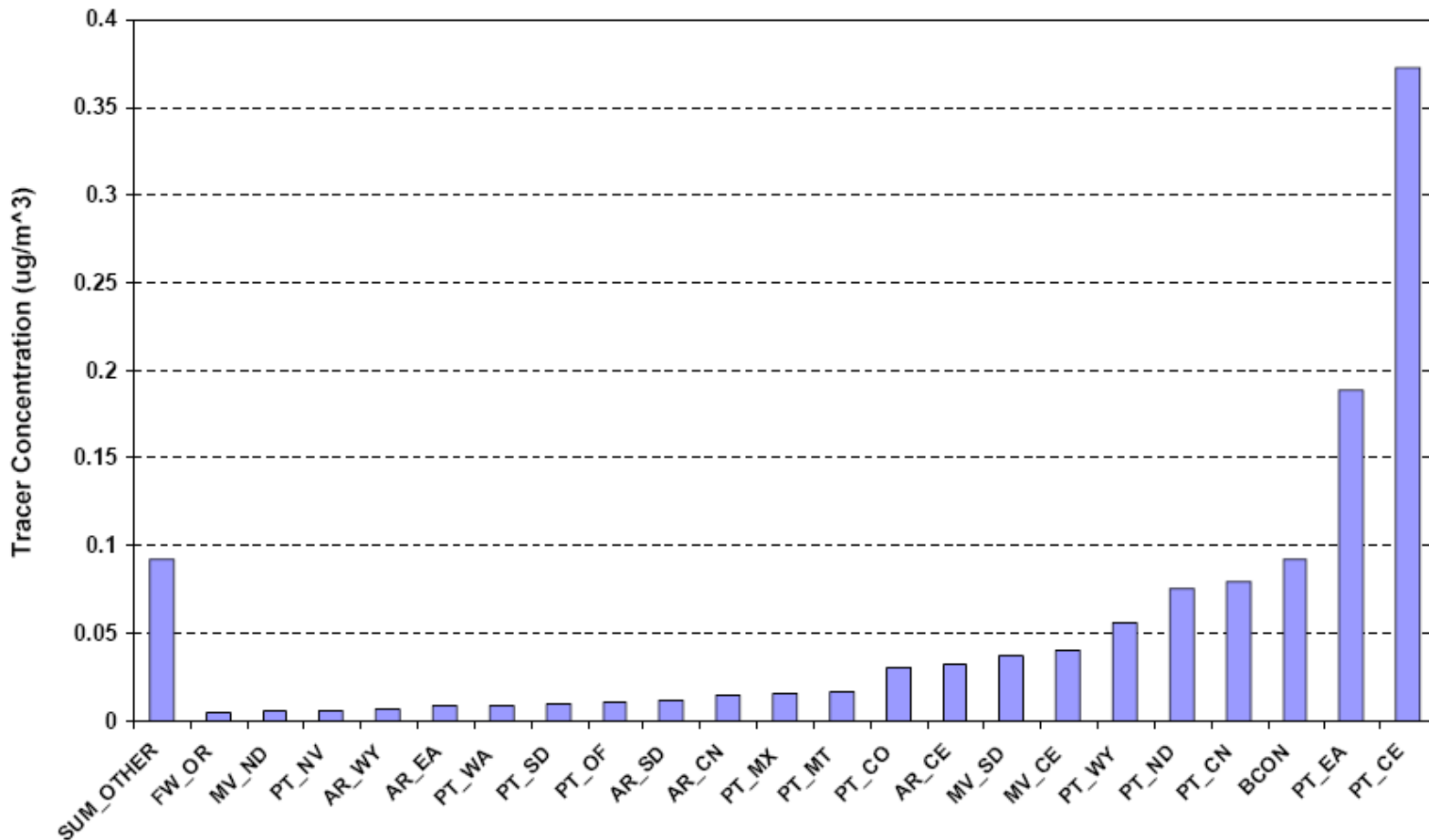
TSSA

Badlands National Park, SD (BADL1)

WRAP Plan02c TSSA Tracers of ASO4: July

Sum of all TRACER Concentration = 1.2168

ACONC = 1.2168



OC Source Apportionment

- Do not include SA treatment of secondary organic aerosols:
 - CMAQ already includes 3 OC species
 - primary organic aerosols
 - biogenic secondary organic aerosols
 - biogenic secondary organic aerosols
 - We have analysis of these species for the various existing model runs might provide info on OC apportionment.

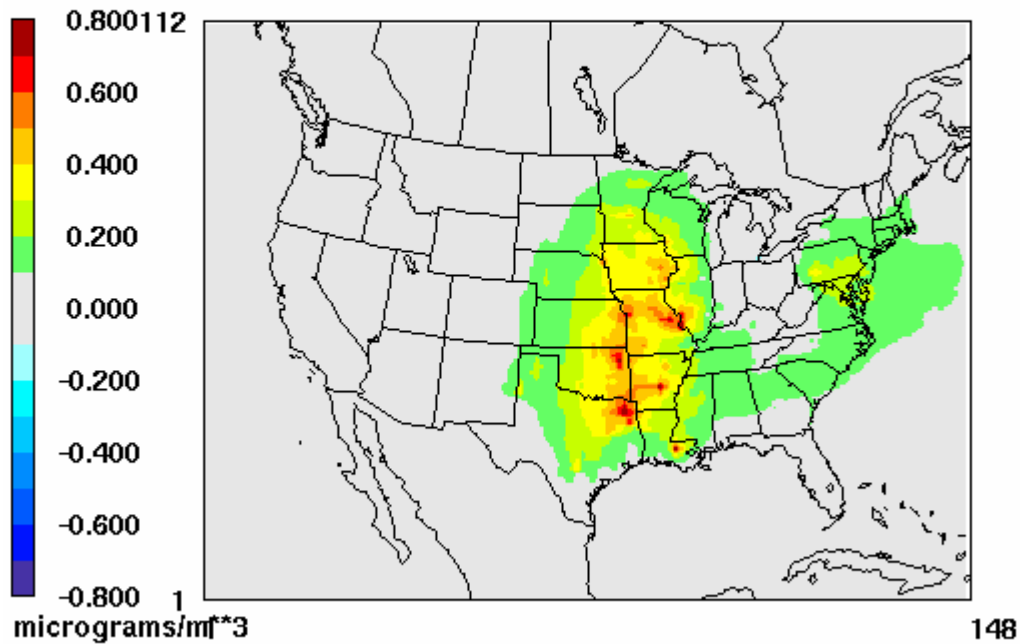
Errors/Uncertainties

- Additional errors have been discovered in the emissions inventories:
 - 2018 B non-WRAP EGU emissions were underestimated.
 - PM_{2.5} emissions in the WRAP road dust inventory.
 - We are evaluating the effects of these errors.

Effects of non-WRAP EGU error July

Delta ASO4

base18c - base18b
Monthly average concentration



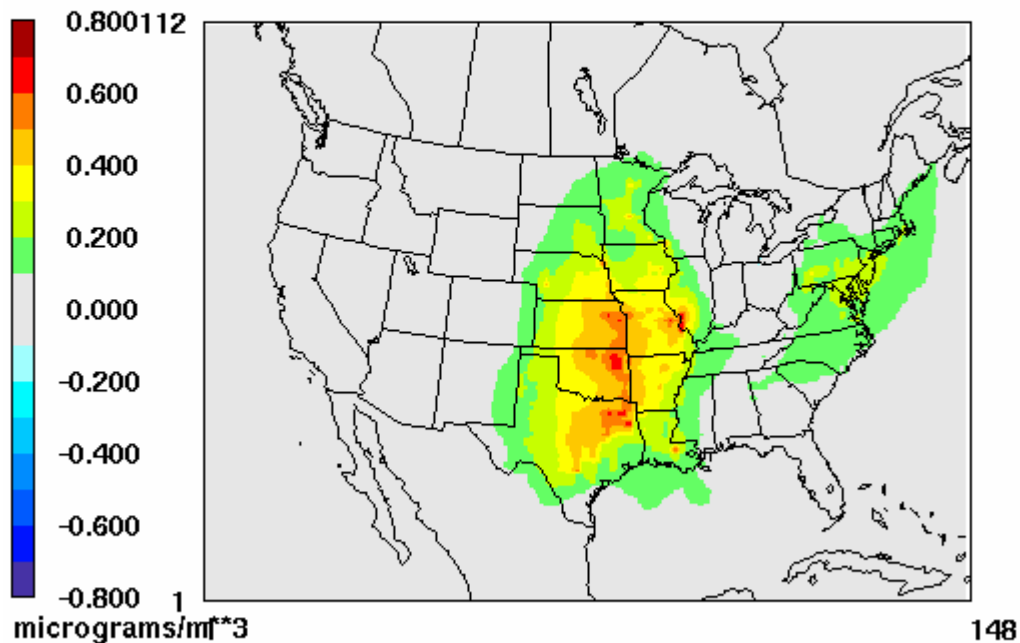
July 1, 2002 0:00:00
Min= -0.173 at (108,67), Max= 0.975 at (82,37)

Effects of non-WRAP EGU error

August

Delta ASO4

base18c - base18b
Monthly average concentration

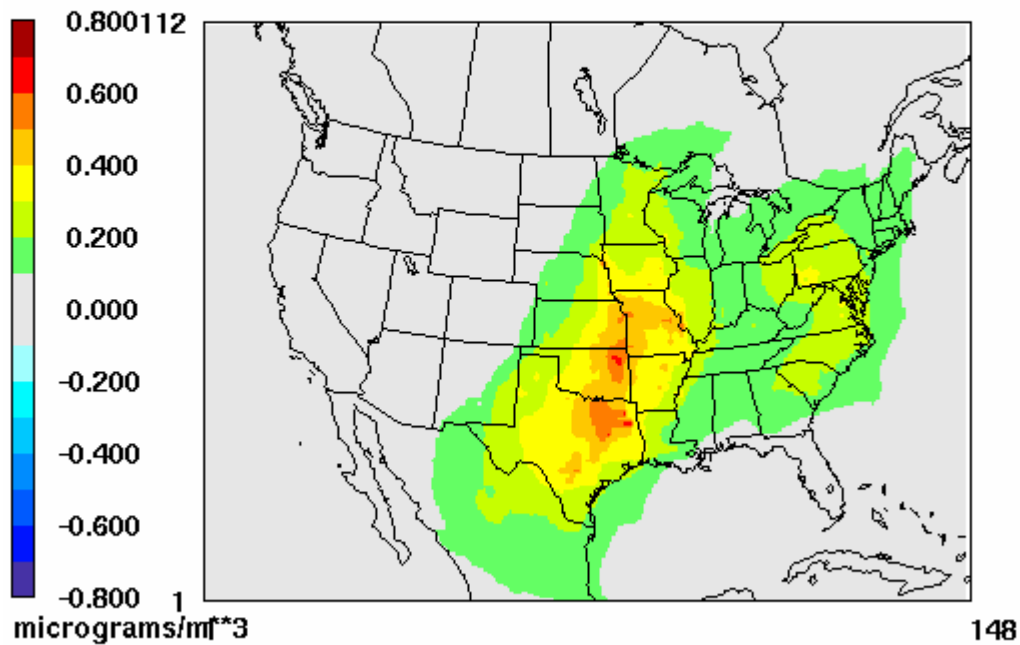


August 1, 2002 0:00:00
Min= -0.126 at (108,67), Max= 0.695 at (82,37)

Effects of non-WRAP EGU error September

Delta ASO4

base18c - base18b
Monthly average concentration



September 1, 2002 0:00:00
Min= -0.000 at (136,12), Max= 0.659 at (83,35)

Summary: Effects of non-WRAP EGU error

- Effects on WRAP states are relatively small.
- Effect is a small over-estimate of progress in 2018 for eastern tier WRAP states.
- Recommend we continue using 2018 B for PSAT results.

Summary

- Plan 2002 C PSAT complete mid August.
- Base 2018 B should be complete late August.
- Will prepare receptor bar plots for the average 20% best and 20% worst days (based on IMPROVE data).
- Results posted on webpage at:
<http://pah.cert.ucr.edu/aqm/308/cmaq.shtml#CAMxPlan02c>