WRAP Regional Haze Analysis & Technical Support System

IMPROVE Steering Committee Meeting

September 27, 2006

Technical Analysis Status Report

- WRAP 2003-08 Strategic Plan identifies Fall 2006 to complete regional analyses supporting haze planning

- Focus now:
  - Planning process
  - Reasonable progress demonstration
  - Control strategy analysis

- Technical work & continuous improvement have been ongoing since 2000
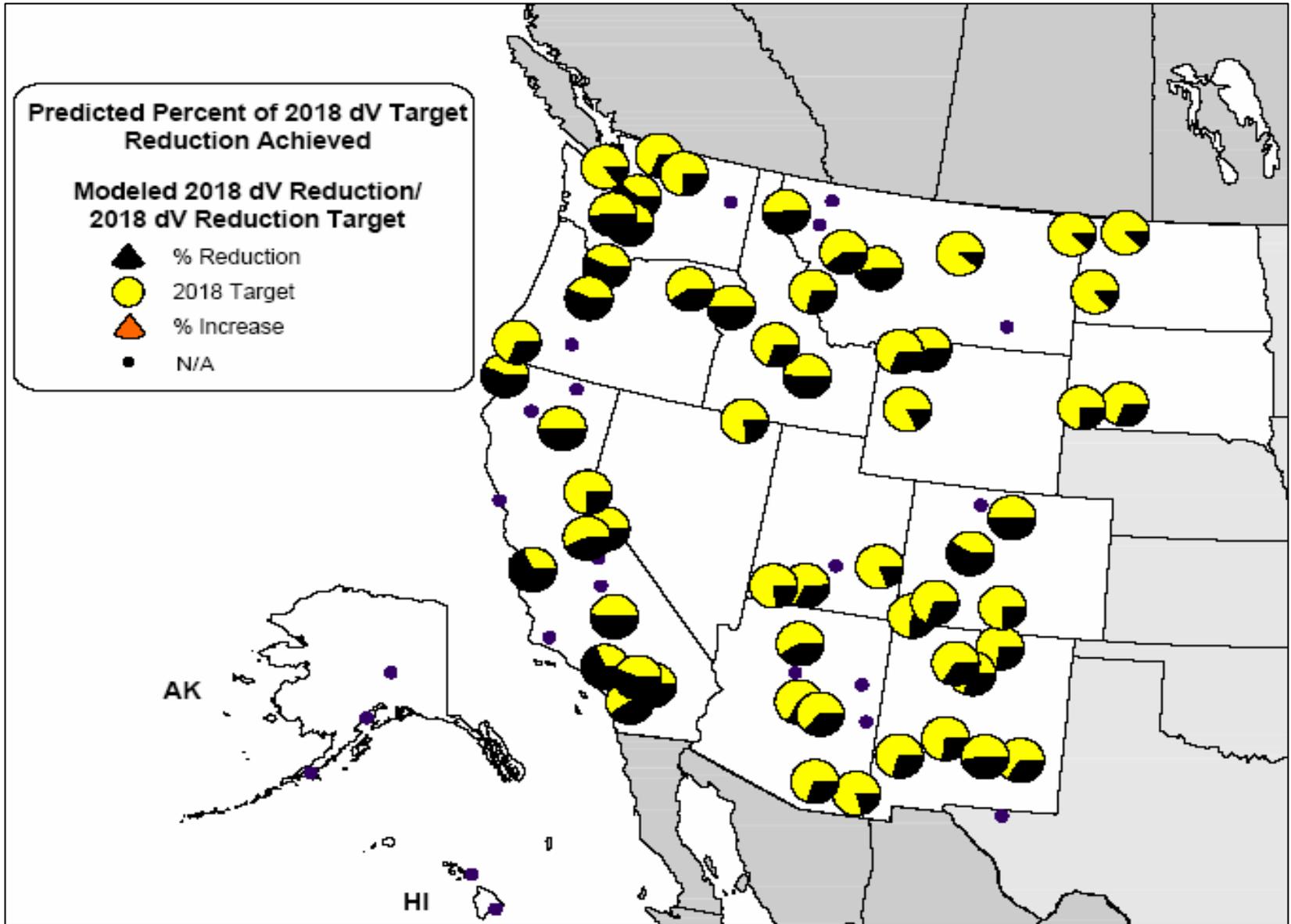
Technical Analysis Results

- WRAP analyses:
  - Comprehensive & complete emissions inventories
  - Monitoring data analysis for all western Class I areas
  - Regional photochemical aerosol modeling
  - Multiple source apportionment methods
  - Results summarized & available for planning
- 5 most important things to know –

#1 – 2018 base case visibility projections are significantly shy of the "Uniform Rate of Progress"

Regional Haze Planning

- Rule promulgated in 1999, much work completed since
- Requires states to set RPGs based on 4 statutory factors and consideration of a Uniform Rate of Progress
- URP = 20% reduction in manmade haze (dv) per planning period (10 years)
- URP heavily dependent on:
  - Assumptions regarding future (2064) natural conditions
  - Contribution of non-WRAP sources to baseline
  - Representativeness of 2000-04 baseline: 1/3 of Class I monitoring sites have no more than 3 years of data in baseline period
 - These issues more acute in the West

2018 Base Case Visibility Projections (deciviews)

Predicted Percent of 2018 dV Target Reduction Achieved

Modeled 2018 dV Reduction / 2018 dV Reduction Target

- ▲ % Reduction
- ⬤ 2018 Target
- ▲ % Increase
- • N/A

Note: Fire & Dust emissions held constant

2000-04 Annual Average WRAP Region PM$_{2.5}$ Emissions (13 States)

(Does not include out-of-region sources)
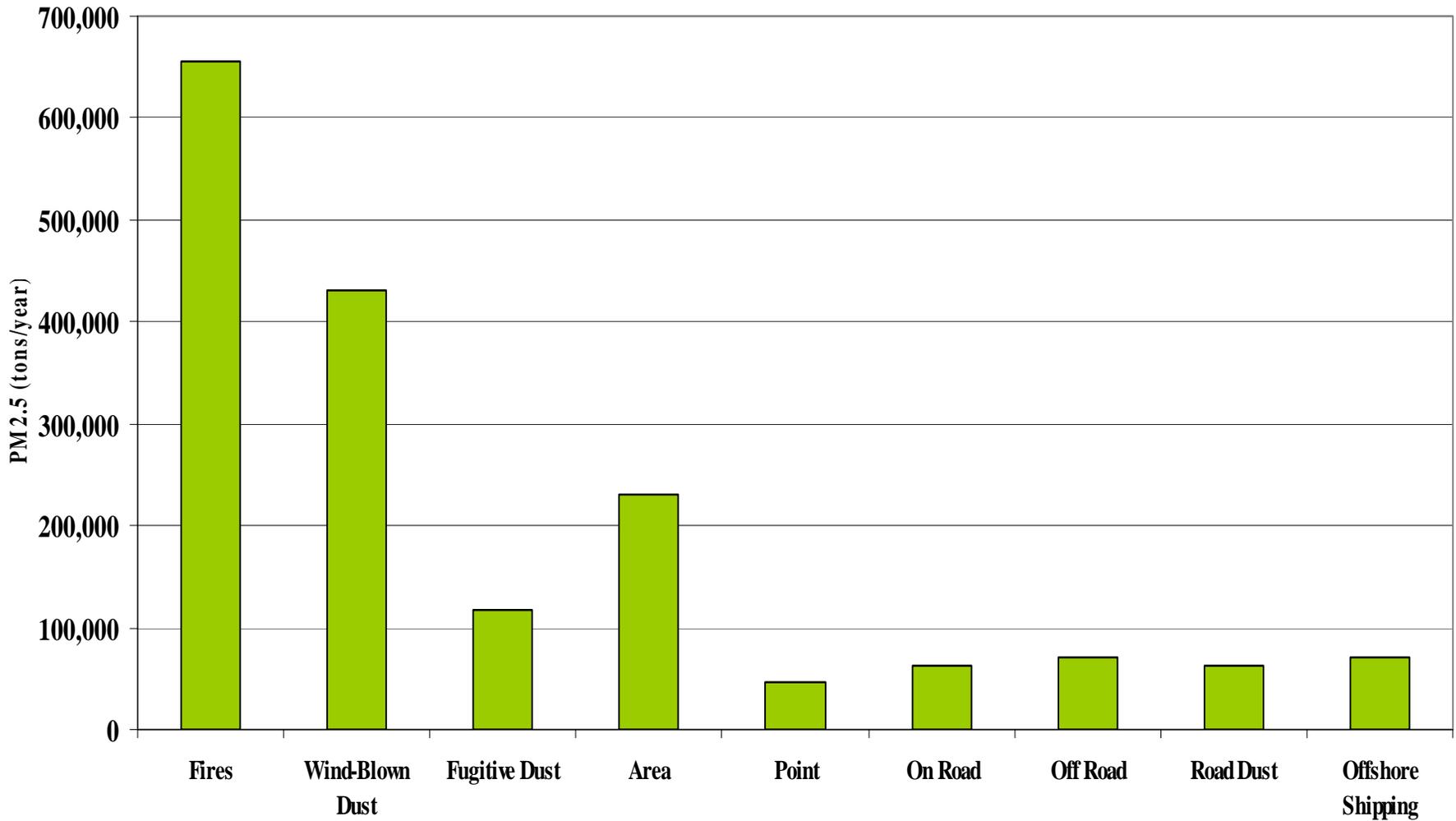
Why A Species-Based Approach to understanding PM & Regional Haze Planning?

- Species differ significantly from one another:
  - Contribution to visibility impairment
  - Spatial and seasonal distributions
  - Source types
  - Contribution from natural & international sources
  - Emissions data quality & completeness
  - Atmospheric science quality
  - Tools available for assessment and projection

WRAP Region Emissions/Air Quality Projections Data for Haze Planning

	SO2	NOx	OC/EC	Fine Soil/CM
Emission Sources	Almost entirely anthropogenic. *Mostly point sources*	Mostly anthropogenic. *Mix of combustion sources*	Diverse. *Mix of anthropogenic, fire, and biogenic VOC sources*	Diverse. *Very difficult to partition windblown dust into natural vs. anthropogenic*
Emissions Data Quality	Very good overall. *Activity data less good for area sources*	Good. *Activity data less good, some coding concerns w/ smaller point, area, and O&G sources*	Fair. *Good activity data & confidence in $PM_{2.5}$ emissions, but uncertain chemistry of $PM_{2.5}$ & biogenic VOCs*	Poor, except for some locales. *Categorically complete but accuracy very uncertain*
Emission Projections	Very good. *Uncertain about area sources*	Good. *Uncertain about offshore and O&G*	Fair. *What to expect from fire?*	Fair. *What to expect from windblown dust?*
Atmospheric Science Quality	Very good. *Meteorology probably largest uncertainty*	Fair. *Chemistry more complex, but meteorology too*	Fair. *Most complex, least understood, but model performance okay*	Fair. *No major chemistry, but model resolution & meteorology insufficient*
WRAP Technical Tools for Haze Planning	Emission Inventories Modeling Projections Modeled Source Apportionment	Emission Inventories Modeling Projections Modeled Source Apportionment	Emission Inventories Modeling Projections Receptor Modeling Weighted Emissions Potential	Emission Inventories Weighted Emissions Potential Causes of Dust Analysis

#2 – WRAP region EGU SO$_2$ emissions are declining

WRAP region EGU SO$_2$ emissions
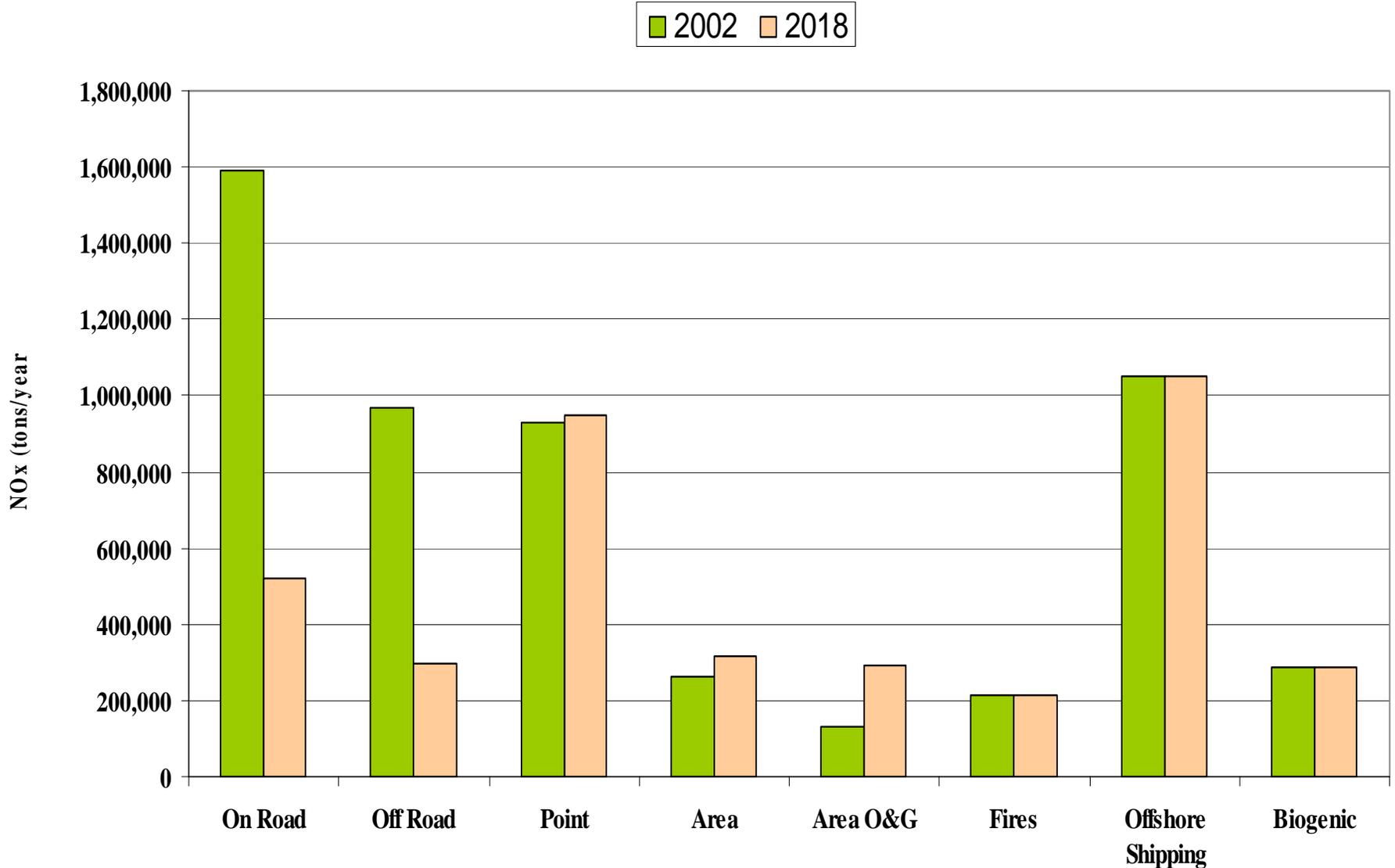
EGU SO2 Emissions Trend
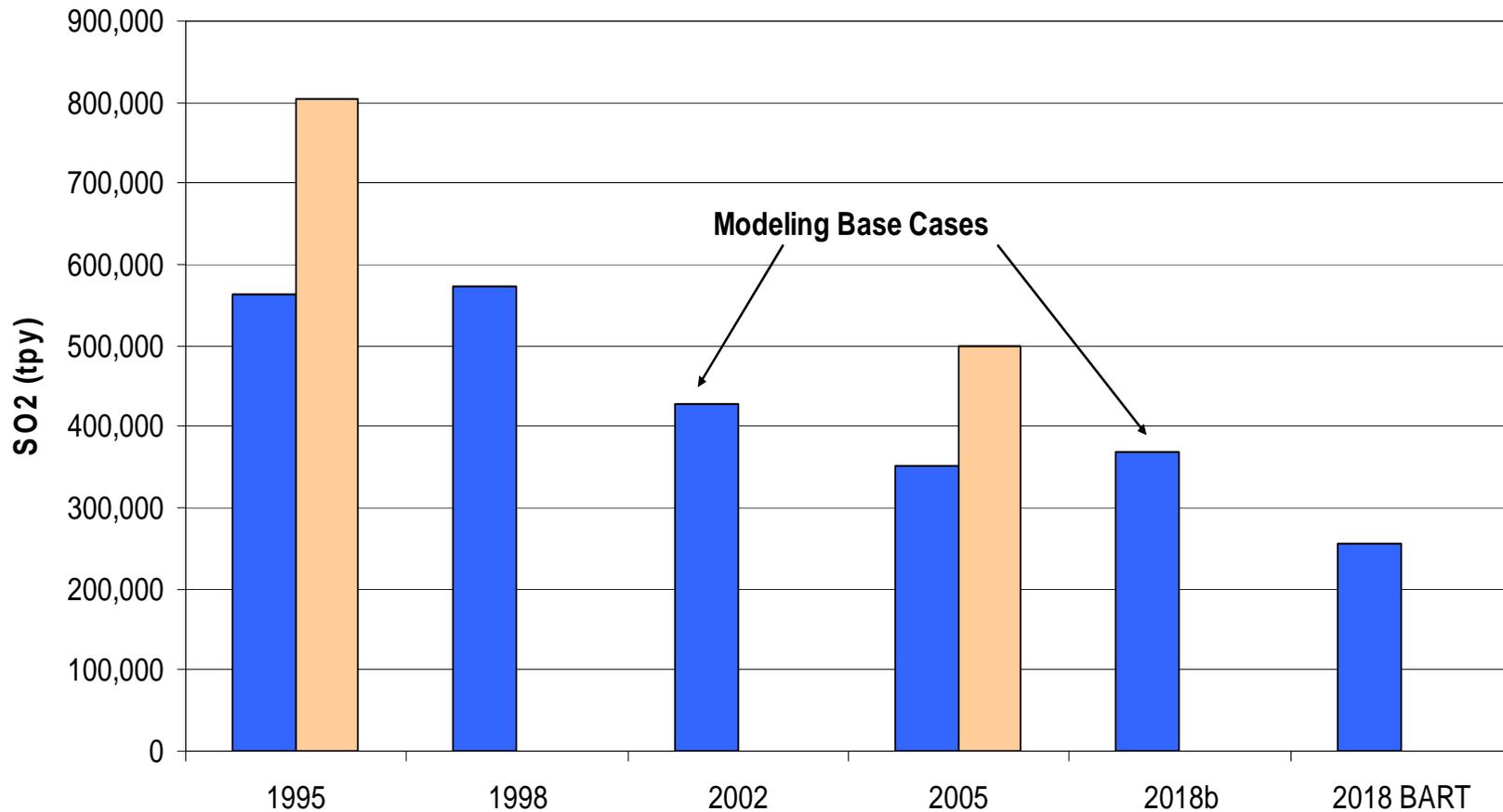
Data Sources: 1995, 1998, and 2005 from EPA Clean Air Markets Division, 2002 emissions and 2018 projections by Eastern Research Group, and 2018 BART assuming presumptive limits in EPA BART rule on units > 200 MW

#3 – Mobile Source NO$_x$ emissions are declining

WRAP region NO$_x$ emissions by source category

Legend: ■ 2002 □ 2018

NO$_x$ (tons/year)

Categories: On Road, Off Road, Point, Area, Area O&G, Fires, Offshore Shipping, Biogenic

Y-axis: 0 to 1,800,000

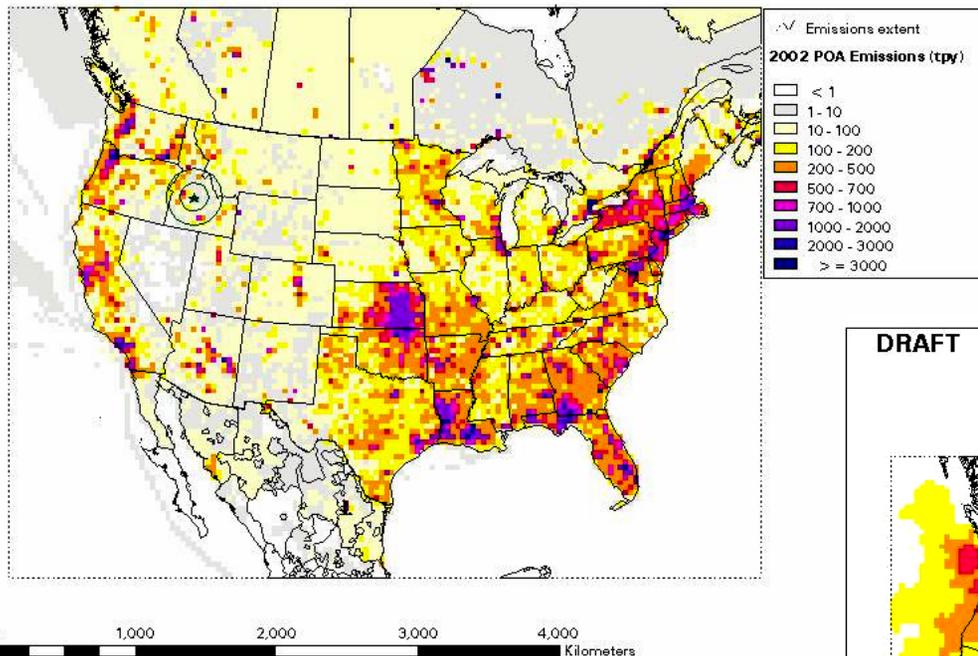**Data Sources: WRAP Forums' emissions inventories and biogenics from BEIS model**

#4 – Source apportionment options for regional haze

a)   Potential of emissions to contribute to regional haze
b)   Source apportionment of SOx & NOx emissions by source region & category contributing to modeled SO4 & NO3, using regional gridded photochemical aerosol model

Example Weighted Emission Potential Method:
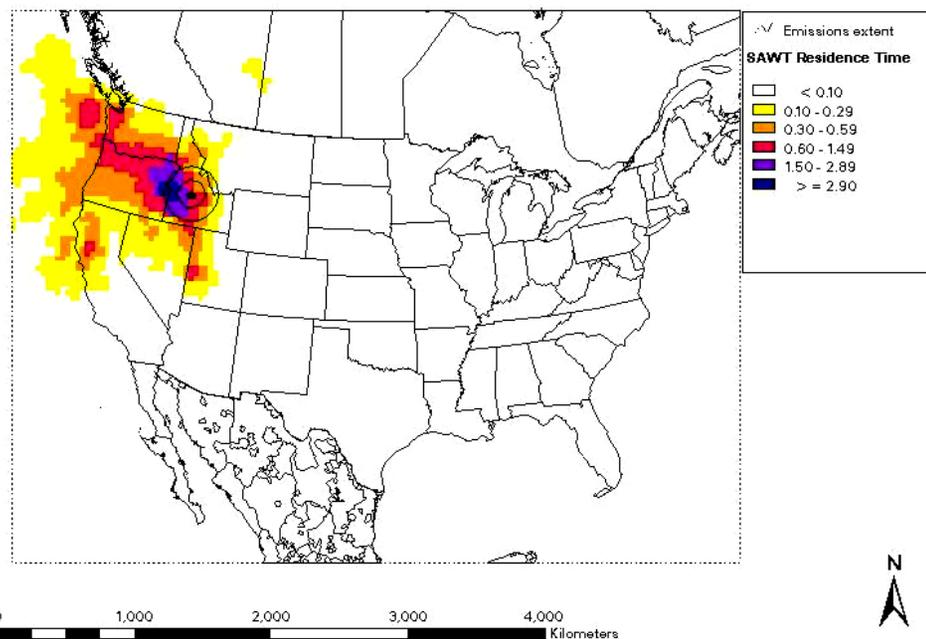# Organic Carbon at Sawtooth Wilderness

Emissions

**multiplied by**

air flow patterns

Data Sources: gridded emissions inventories from Regional Modeling Center, gridded air mass residence time from Desert Research Institute

Example Weighted Emission Potential Products: Organic Carbon at Sawtooth Wilderness
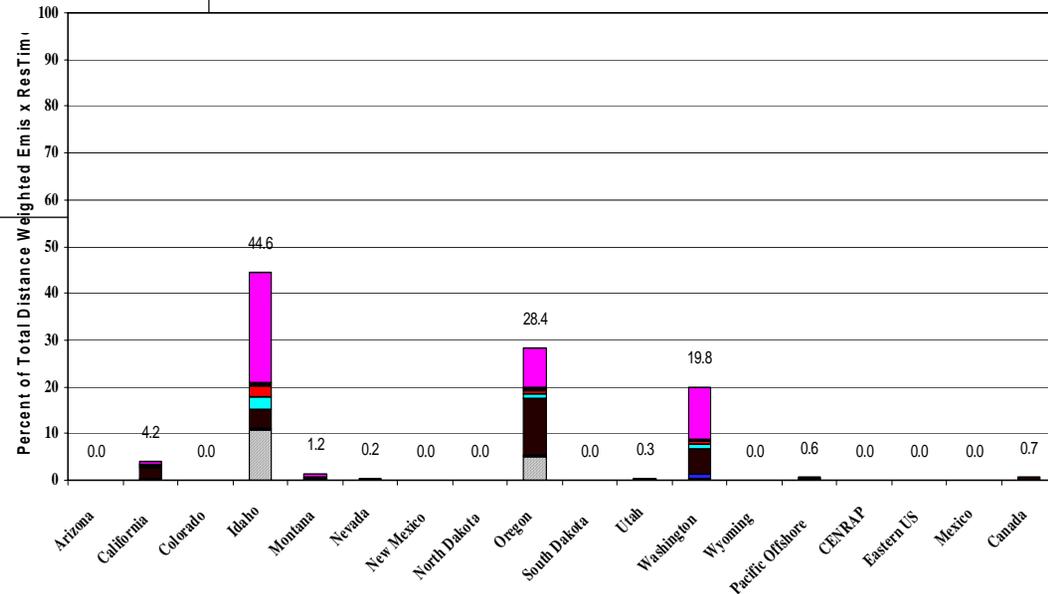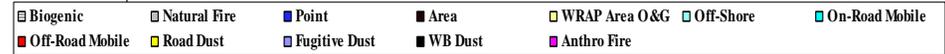

DRAFT

Sawtooth Wilderness

Emissions extent

SAWT 2002 POA E*RT
(dist-wtd, normalized)
- < 0.10
- 0.10 - 0.39
- 0.40 - 0.99
- 1.00 - 2.99
- >= 3.00
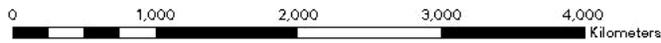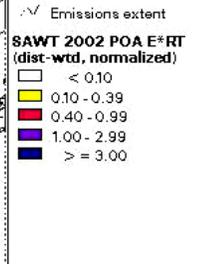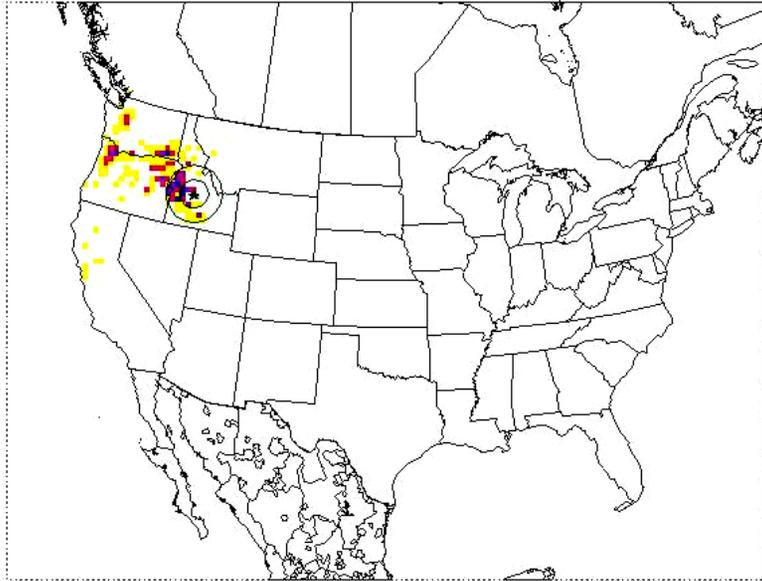
and

Sources and Areas of Potential Organic Carbon Emissions Influence
2000-2004 Baseline for Sawtooth Wilderness

Legend: Biogenic, Natural Fire, Point, Area, WRAP Area O&G, Off-Shore, On-Road Mobile, Off-Road Mobile, Road Dust, Fugitive Dust, WB Dust, Anthro Fire

Source Apportionment Technique

- Regional gridded photochemical CAMx air quality aerosol model with PM Source Apportionment Technology (PSAT)
- Similar to CMAQ Tagged Species Source Apportionment method previously used by WRAP, best available modeling analysis technique for source apportionment
- PSAT completed for 2 cases:
  - Plan02c
    - 2000-04 average fire emissions, same time & place
    - 2000-03 CAMD sources' monthly average SOx/NOx profiles by state
  - Base18b – rules on the books controls and growth
- Tracked sources of sulfate and nitrate
- Tracking organic carbon too computationally intensive

Organic Carbon Source Apportionment

- PSAT work does not include treatment of primary & secondary organic aerosols:
  - CMAQ analysis already completed by WRAP includes 3 OC species "naming conventions"
    - primary organic aerosols
    - anthropogenic secondary organic aerosols
    - biogenic secondary organic aerosols
  - Analysis of these species for the various existing model runs will provide additional information on OC apportionment

Source Apportionment Modeling

- White paper describing 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

PSAT: 18 Source Regions on a 36 km Grid plus Initial and Boundary Conditions
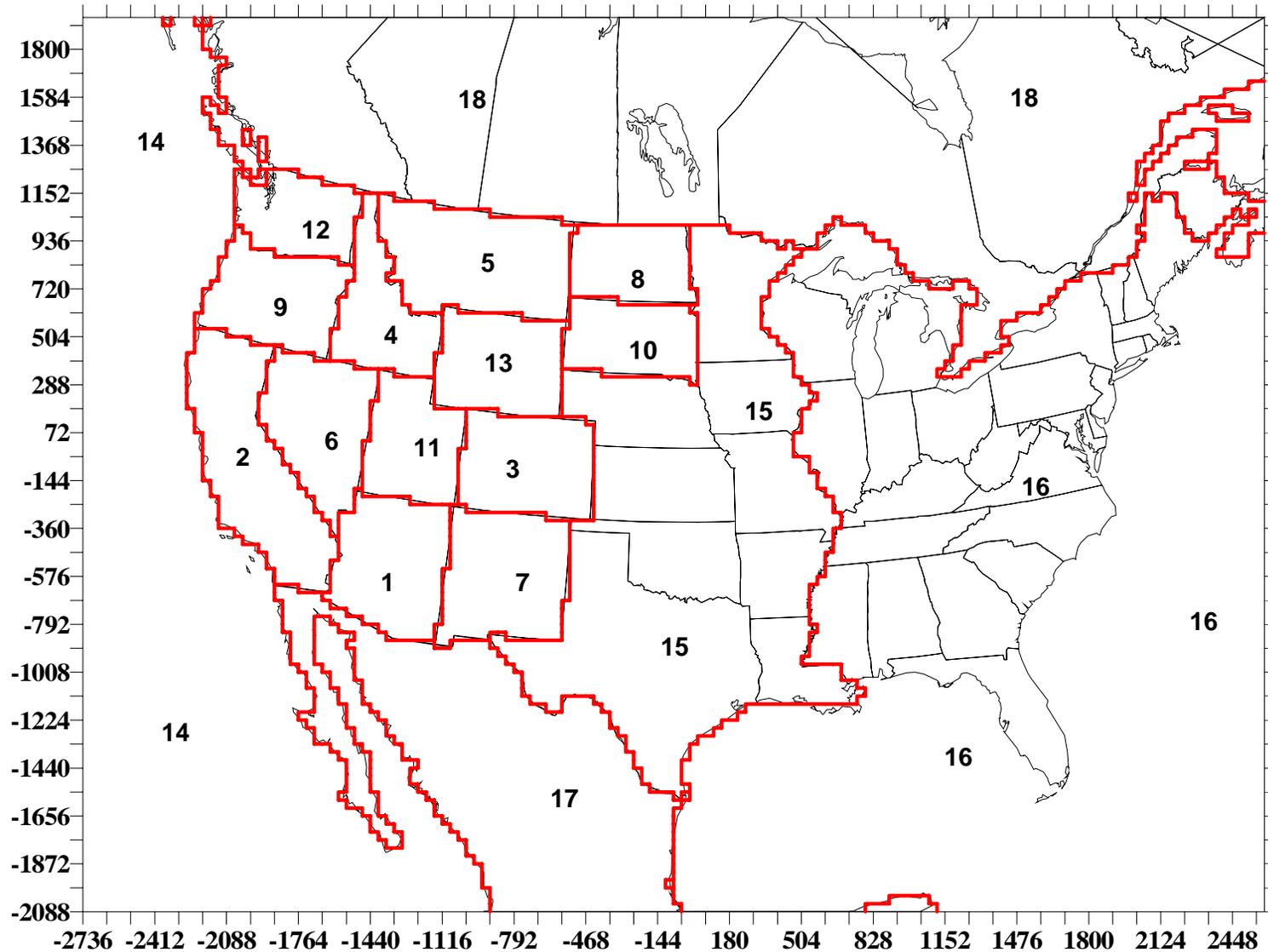
PSAT: 6 Source Categories

PT	Point sources
MV	Mobile sources
ANF	WRAP anthropogenic fires
Natural	WRAP natural fires and biogenics
NWF	Elevated fires in other RPOs
AR	All other sources (non-elevated fires in other RPOs, area sources, offshore, oil & gas area sources, etc.)

- Examples of PSAT results: "source by region":
  - MV_CO = mobile sources in Colorado
  - PT_CE = point sources in CENRAP
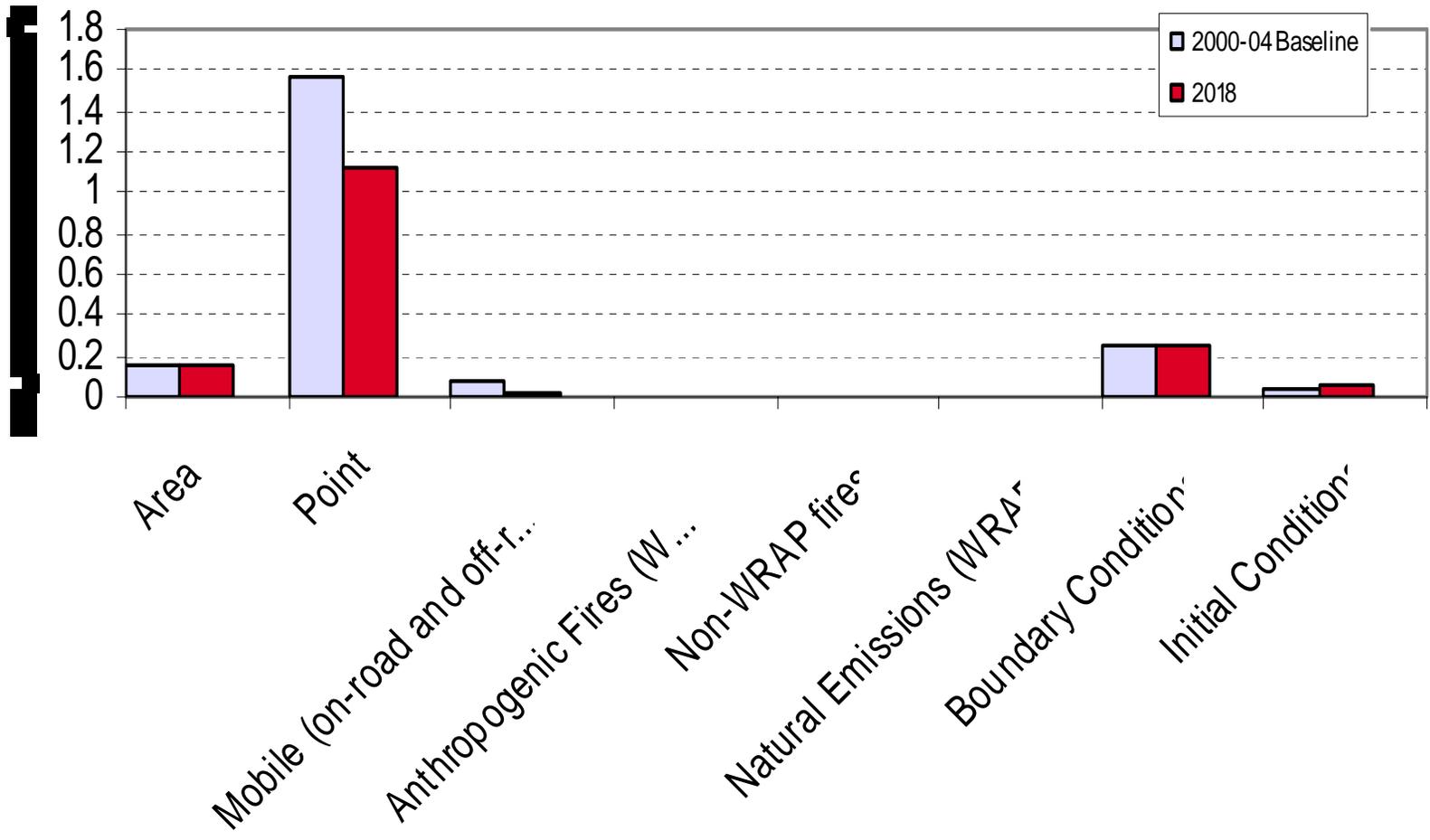
Modeled Source Apportionment Example
Sulfate on 20% Worst Days -- Salt Creek, NM

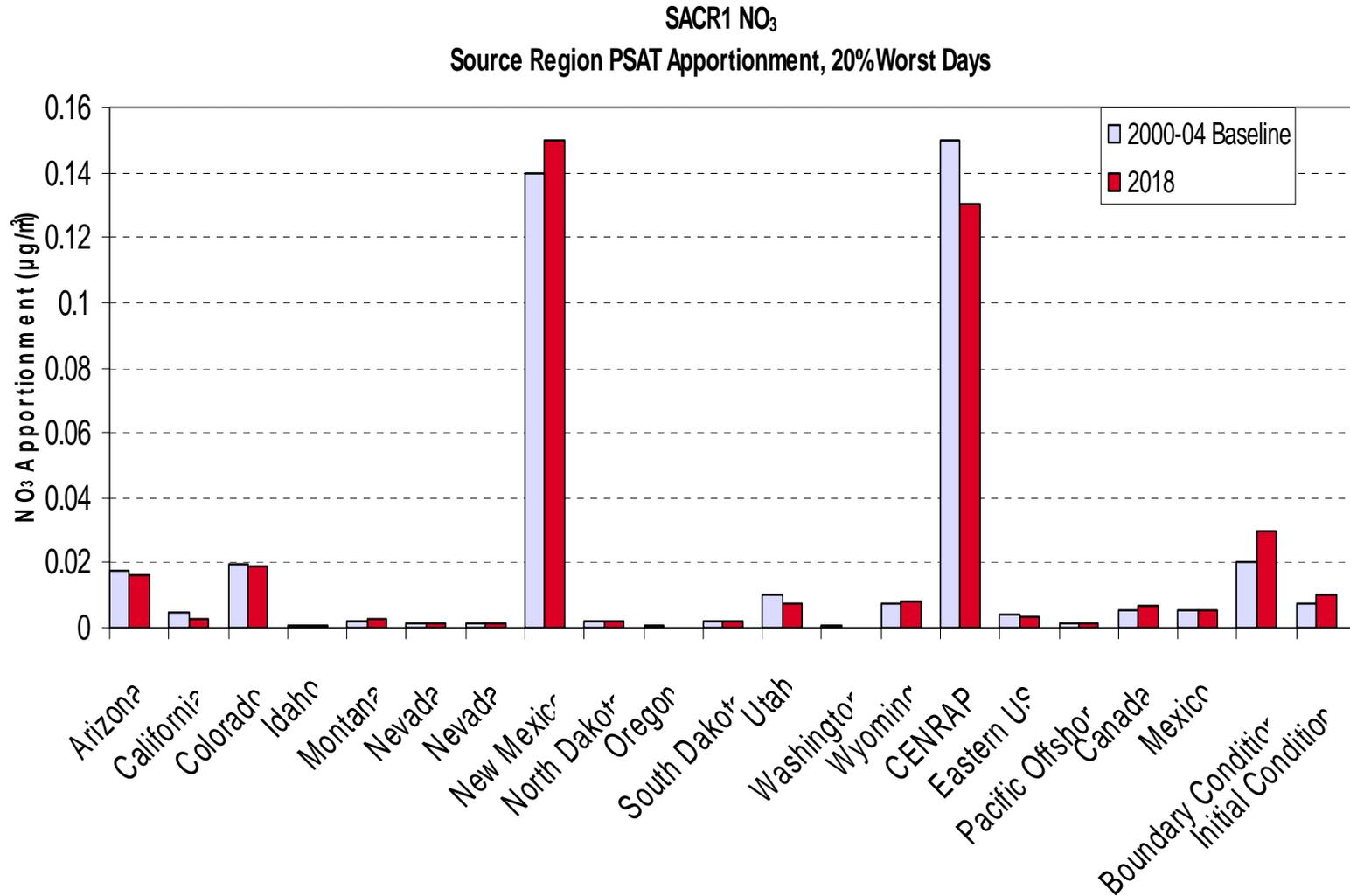SACR1 SO$_4$

Source Region PSAT Apportionment, 20%Worst Days
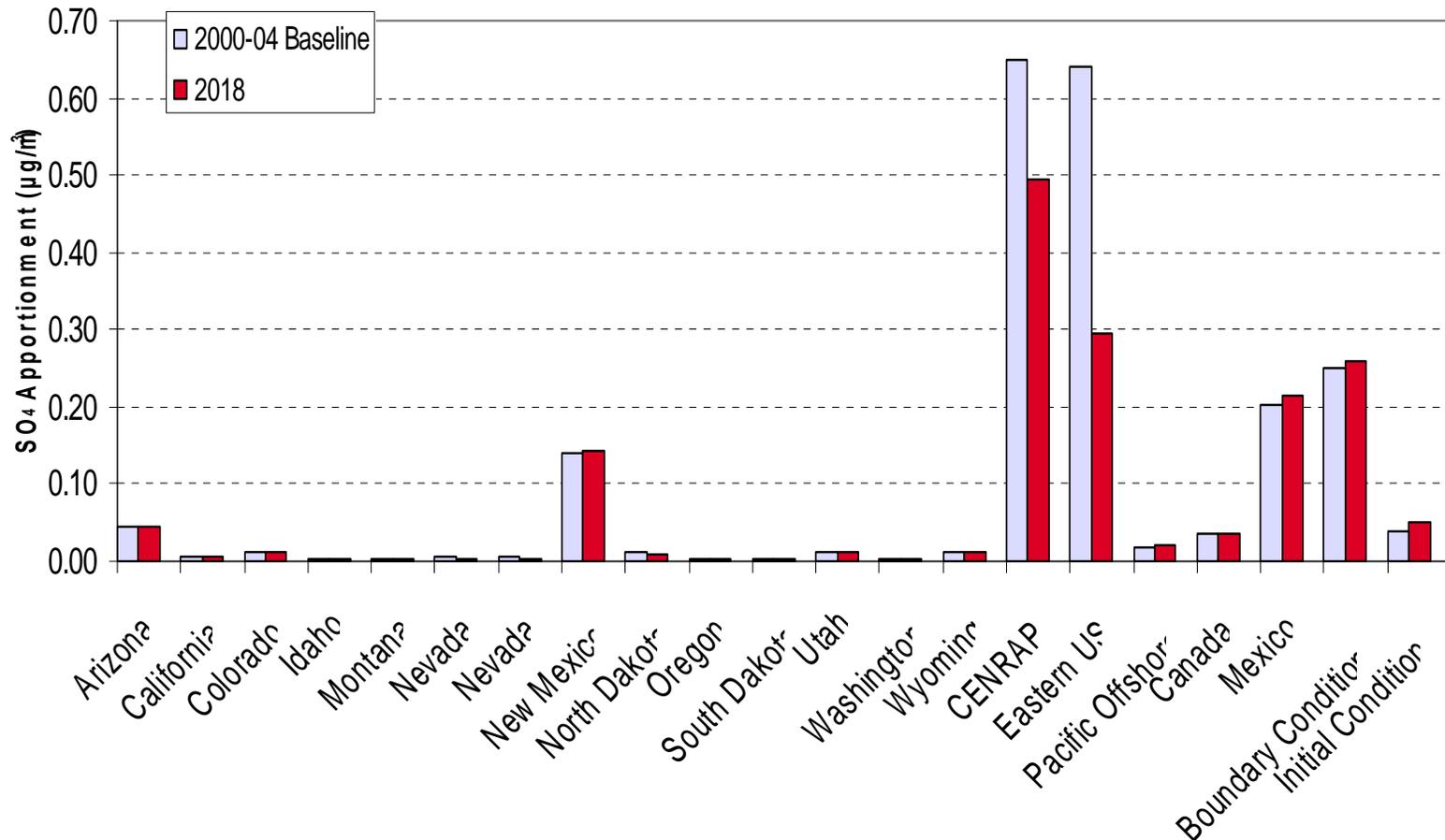
Modeled Source Apportionment Example
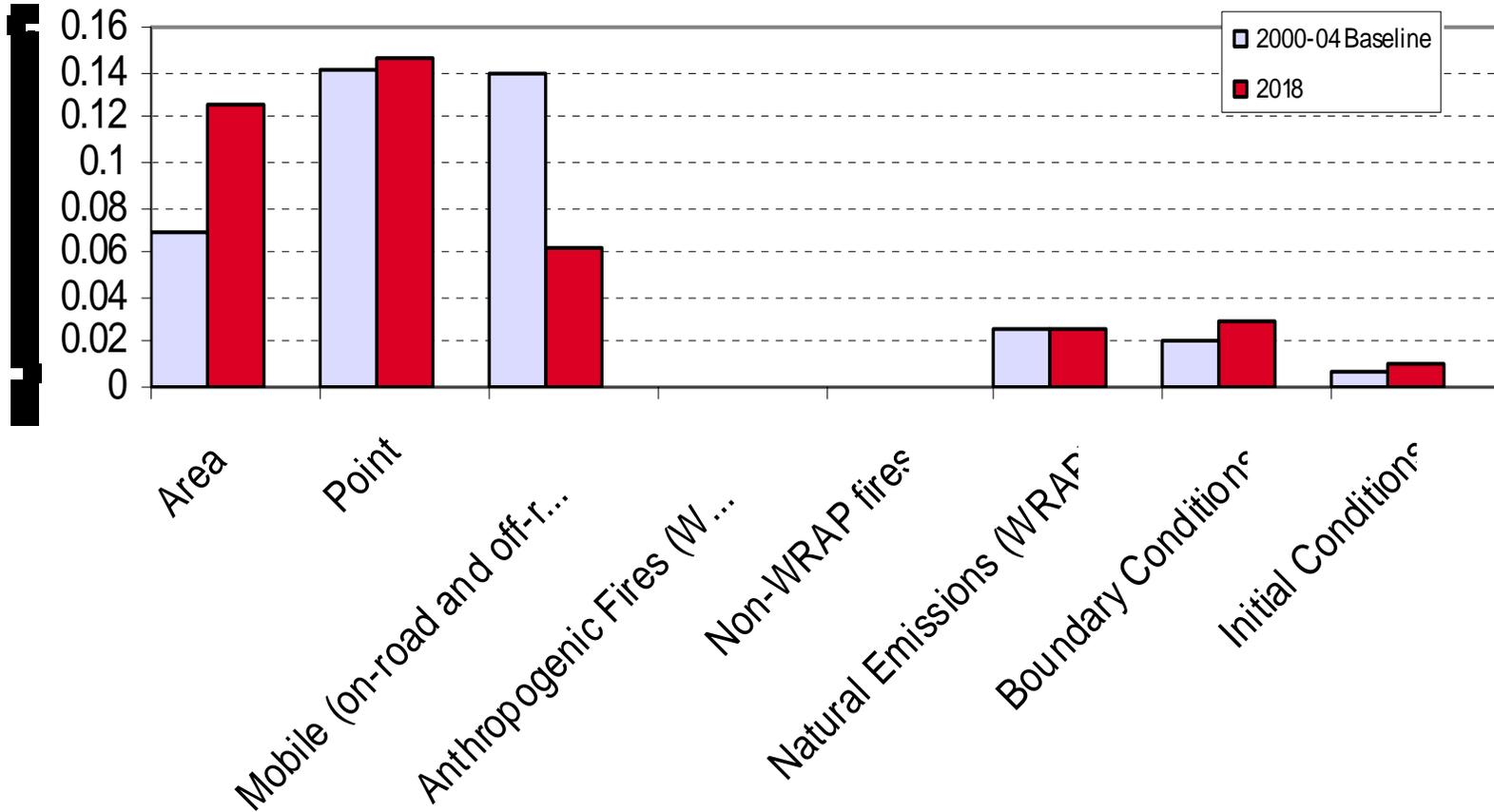# Sulfate on 20% Worst Days -- Salt Creek, NM

Modeled Source Apportionment Example
Nitrate on 20% Worst Days -- Salt Creek, NM

SACR1 NO₃
Source Region PSAT Apportionment, 20% Worst Days

**Modeled Source Apportionment Example
Nitrate on 20% Worst Days -- Salt Creek, NM**
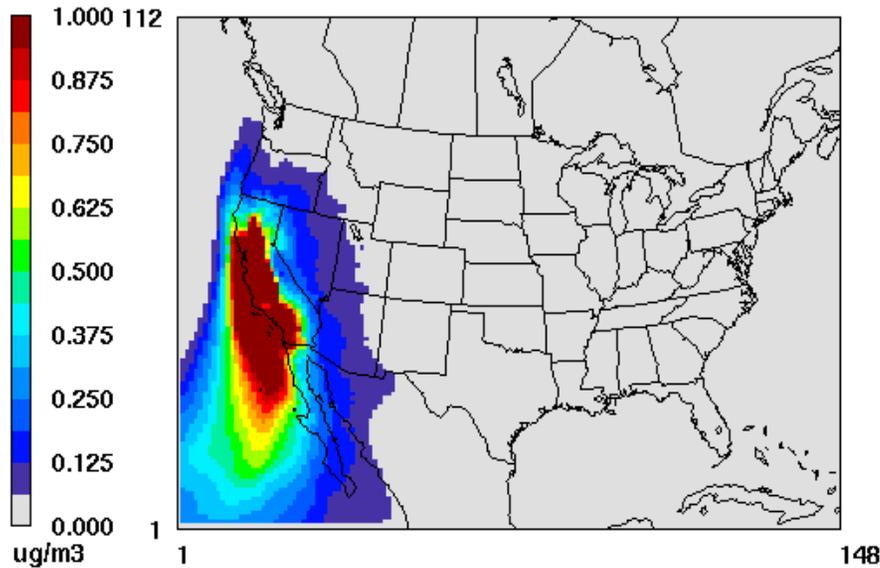
Modeled Source Apportionment Map Example
California Mobile Source Nitrate Contribution
(January Average)

2000-04

PNO3 Mobile Source CA
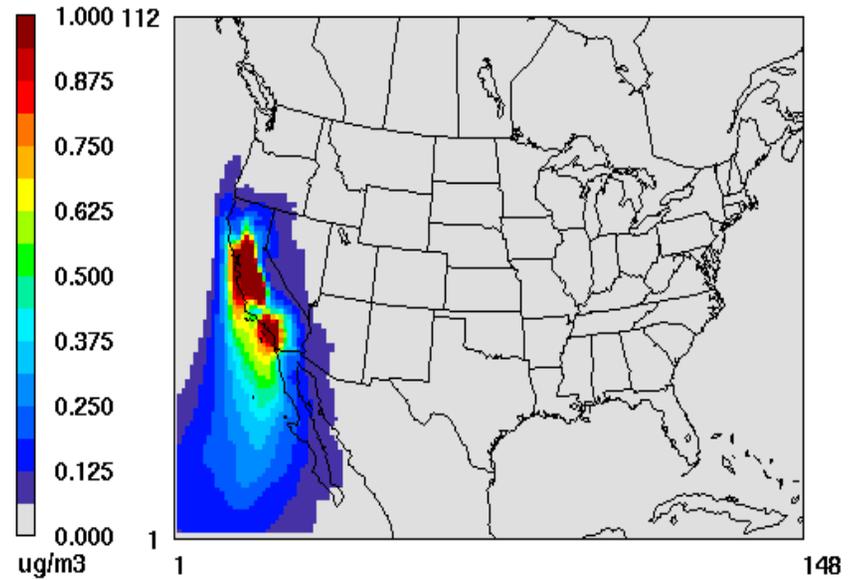
CAMx Planning 02c
Monthly Average: January

January 1,2002 0:00:00
Min= 0.000 at (1,1), Max= 5.059 at (19,58)

2018

PNO3 Mobile Source CA

CAMx Base 18b
Monthly Average: January

January 1,2018 0:00:00
Min= 0.000 at (1,1), Max= 2.341 at (23,46)

Modeled Source Apportionment Map Example
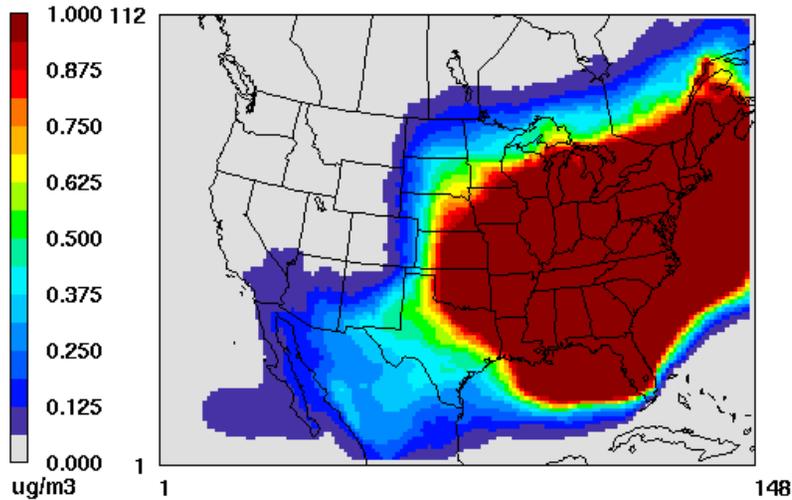# Eastern US Point Source Sulfate Contribution
(July Average)

2000-04

2018

PSO4 Point Source Eastern

CAMx Planning 02c
Monthly Average: July

1.000 112
0.875
0.750
0.625
0.500
0.375
0.250
0.125
0.000
ug/m3 1
1   148

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

PSO4 Point Source Eastern

CAMx Base 18b
Monthly Average: July

1.000 112
0.875
0.750
0.625
0.500
0.375
0.250
0.125
0.000
ug/m3 1
1   148
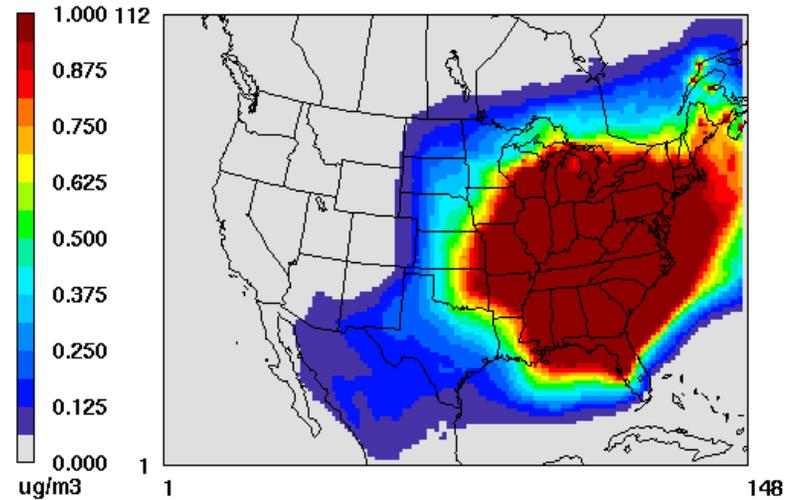
July 1,2002 0:00:00
Min= 0.000 at (1,1), Max= 4.924 at (103,40)
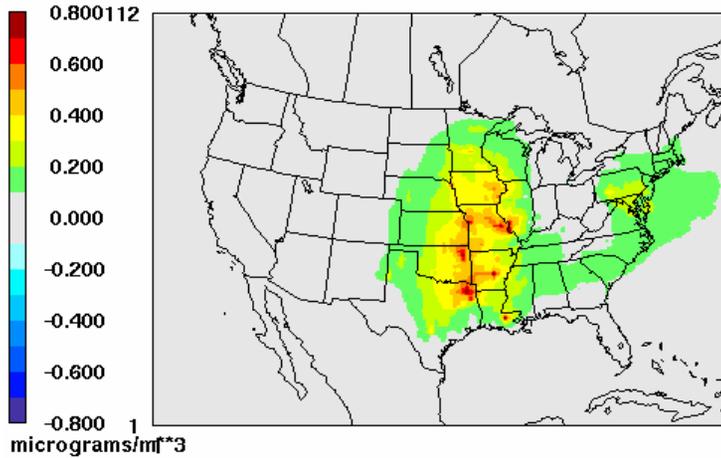
PSAT: Errors/Uncertainties

- Additional errors have been discovered in the emissions inventories:
  - Base18b non-WRAP EGU emissions were underestimated.
  - $PM_{2.5}$ emissions in the WRAP road dust inventory.
  - RMC is evaluating the effects of these errors.

Effects of non-WRAP EGU error

July

August
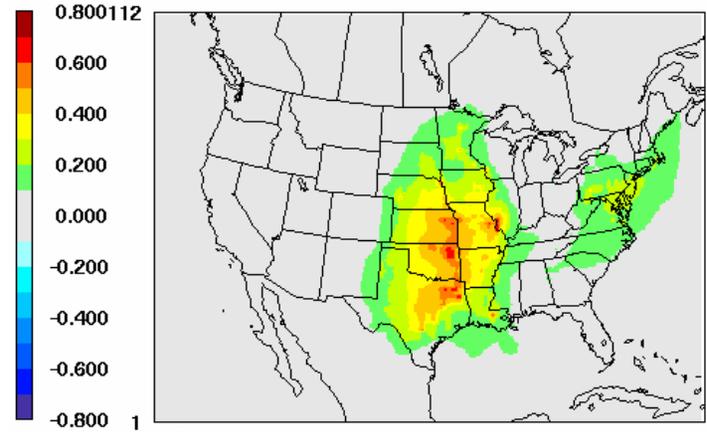
Delta ASO4

base18c – base18b
Monthly average concentration

0.800112
0.600
0.400
0.200
0.000
-0.200
-0.400
-0.600
-0.800

micrograms/m**3

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

Delta ASO4

base18c – base18b
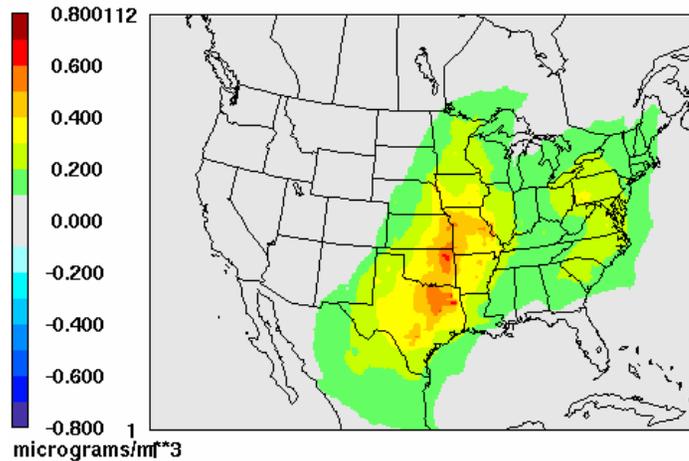Monthly average concentration

0.800112
0.600
0.400
0.200
0.000
-0.200
-0.400
-0.600
-0.800

148

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

Delta ASO4

base18c – base18b
Monthly average concentration

0.800112
0.600
0.400
0.200
0.000
-0.200
-0.400
-0.600
-0.800

micrograms/m**3

September

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

Effect on PSAT results of non-WRAP EGU error

- Air quality prediction effects on WRAP states are relatively small.

- Small overestimate of base case progress in 2018 for eastern tier of WRAP region states.

- Base18b sufficient as starting point for development of regional haze control strategies

- Will correct non-WRAP region EGU error in "Control18" series of modeling simulations in 2007

#5 – Technical Support System developed

Lessons learned from §309 technical support

Technical Support Document (TSD)

The final version of the regional Section 309 TSD, dated December 15, 2003, addresses the technical analyses and provides information used in preparing the 309 plans due by the end of 2003. Analyses and supporting technical information needed after the SIP submittals and EPA review will be addressed in a separate document(s).

- Download TSD PDF (6.9 mb)

Excel spreadsheets summarizing county-level emissions inputs to the air quality modeling runs have been prepared by WRAP Regional Modeling Center. These are the emissions modeled in the two Section 309 control scenarios, and in the various control strategy and sensitivity runs. These emissions inputs are described in the Chapter 1 Modeling section of the TSD.

- Download spreadsheets containing Emission Inventories Used in the 309 Modeling Runs (9 Excel files)
  - 1996 Base Case Emissions Final XLS (2 MB)
  - 2018 Base Case Emissions Final XLS (2 MB)
  - 2018 Scenario 1 Emissions Final XLS (2 MB)
  - 2018 Scenario 2 Emissions Final XLS (2 MB)
  - 2018 BART with Uncertainty Emissions Final XLS (2 MB)
  - 2018 SO2 Annex Milestones Emissions Final XLS (2 MB)
  - 2018 Stationary Source 50% decrease in NOx Emissions Final XLS (2 MB)
  - 2018 Stationary Source simultaneous 25% increase in NOx and PM10 Emissions Final XLS (2 MB)
  - 2018 Stationary Source 50% decrease in PM10 Emissions Final XLS (2 MB)

Technical Support System

- **Summary of key technical data to support regional haze planning & implementation – version 1 on-line mid-October 2006**

- **Supports consultation & interstate emissions/visibility tracking**

- **Documents resources & methods**

- **Interactive data displays:**
  - **Monitoring**
  - **Emissions**
  - **Modeling/Source Apportionment Results**
  - **Ancillary GIS information**

- **To assess progress, provides tracking of:**
  - **Periodic emissions inventories & emissions reductions programs**
  - **Visibility monitoring data**
  - **Modeling/Source Apportionment Results**

Welcome to the WRAP Technical Support System!

1. **Getting Started with the TSS**

2. **Attribution of Haze Results**

3. **Regional Haze Planning Support**

4. **Weight of Evidence Checklist**

5. **User Defined Queries & Analyses**

http://vista.cira.colostate.edu/tss/

Examples of WRAP TSS Displays & Tools

Weight-of-Evidence Tool

http://vista.cira.colostate.edu/tss/Tools/WOEChecklist.aspx

Source Apportionment Display Tool

http://vista.cira.colostate.edu/tss/Tools/SA.aspx