Air Quality Modeling to Support Interstate Transport Rulemakings in the EPA Office of Air and Radiation

Western States Modeling Workshop

June 2013

Legal Context: Review from Webinar Requirements of Section 110 (a)(2)(D)(i)(I)

- Section 110(a)(2)(D)(i)(I) (the "good neighbor" provision) of the Clean Air Act requires every state's SIP to:
  - "…contain adequate provisions … prohibiting, consistent with the provisions of this subchapter, any source or other type of emissions activity within the State from emitting any air pollutant in amounts which will … contribute significantly to nonattainment in, or interfere with maintenance by, any other State with respect to any [NAAQS]"
- "Good neighbor" SIPs are required for each pollutant covered by a NAAQS (including each revision) and must also address identified precursors to those pollutants
- The "good neighbor" provision applies to all states regardless of whether they contain nonattainment areas
- Each state has an obligation to prohibit emissions that "significantly contribute to nonattainment" or "interfere with maintenance" of the NAAQS in another state

Source Sensitivity & Contribution

How will the modeled concentrations change based on changes to emissions?

Source sensitivity approaches

- Brute force zero out
- Decoupled Direct Method (DDM)

What are the various contributors to modeled concentrations?

Source contribution approaches

- Ozone and PM source apportionment (OSAT, APCA, PSAT, TSSA)
- Adding additional inert PM2.5 tracers (carbon tracking)

All techniques have strengths and limitations

Source Sensitivity & Contribution

- Photochemical model source sensitivity approach (DDM) estimates sensitivity coefficients that relate emissions changes from specific emissions sources to model outcomes at each hour and grid cell

- Photochemical model source apportionment tracks the formation and transport of ozone and PM2.5 from specific emissions sources and calculates contribution at each hour and grid cell

- Source groups may be single sources, groups of sources (sector, fires, biogenics, etc), entire States, or entire Counties

- Receptors are each individual grid cell--which may be matched to any monitor located in the model domain

Brute Force Zero Out

Advantages

- Simple to execute and simple to interpret
- Efficient when examining the impact from a few sources or source groups

Disadvantages

- For larger problems, the approach becomes expensive due to iterative model runs
- When evaluating the impacts from many large emissions source groups, the impacts do not sum up to the original modeled concentrations due to nonlinearities in the system

Decoupled Direct Method (DDM)

Advantages

- Efficient when looking at a larger group of emissions sources
- Essentially provides a model response surface which can act as a stand alone reduced form model for future purposes

Disadvantages

- Most problems require additional pre-processing of emissions and staff expertise to interpret the results
- Technique most applicable to emissions perturbations <50%, less agreement with brute force for emissions changes >50%
- Summing sensitivities will not be equivalent to the original modeled concentration

Source Apportionment

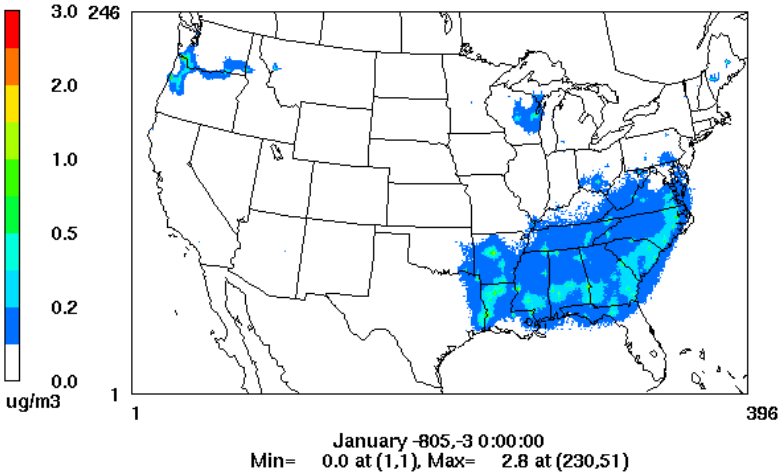
Advantages

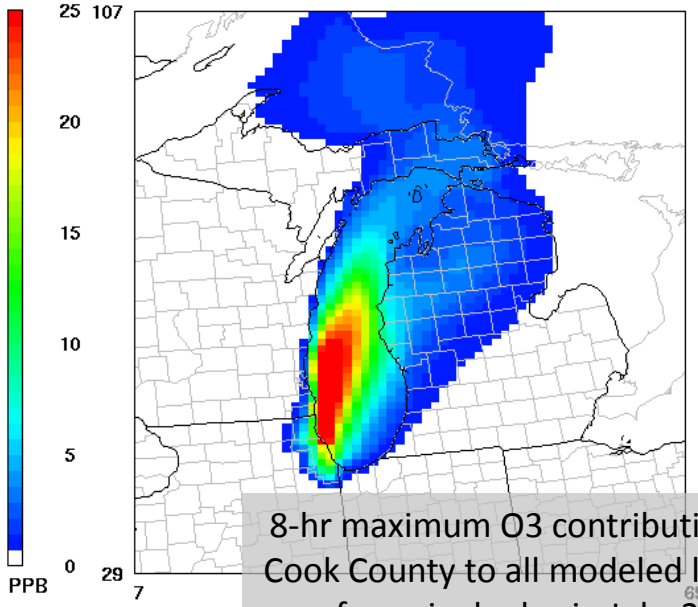
- Efficient when looking at a larger group of emissions sources
- Contributions add up to the original modeled concentrations (does not perturb important atmospheric chemical processes)

Disadvantages

- Most problems require additional pre-processing of emissions and staff expertise to interpret the results
- Technique does not provide information about how the model will respond to emissions changes

Annual average PM2.5 contribution from Pulp & Paper sector

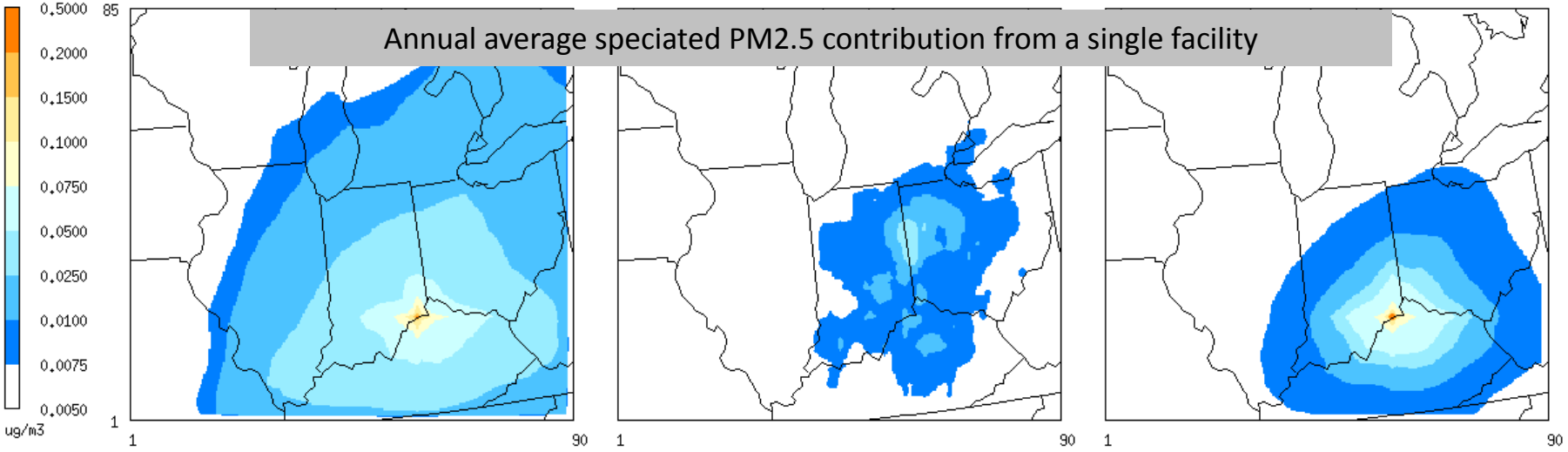




8-hr maximum O3 contribution from Cook County to all modeled locations for a single day in July, 2005

Annual Avg PM2.5 Sulfate | Annual Avg PM2.5 Nitrate | Annual Avg Primary PM2.5

Annual average speciated PM2.5 contribution from a single facility



Cross State Air Pollution Rule (CSAPR)

Section 110 Transport Requirements and Rulemaking History

- CAA Section 110(a)(2)(D)(i)
  - Each plan shall….*contain adequate provisions… (i) prohibiting, consistent with the provisions of this subchapter, any source or other type of emissions activity within the State from emitting any air pollutant in amounts which will— (I) contribute significantly to nonattainment in, or interfere with maintenance by, any other State with respect to any such national primary or secondary ambient air quality standard*
- NOx SIP call (1998) covered 1-hr ozone NAAQS
- CAIR (2005) covered the 1997 8-hr ozone and annual PM2.5 NAAQS

Transport Rule/CSAPR Timeline

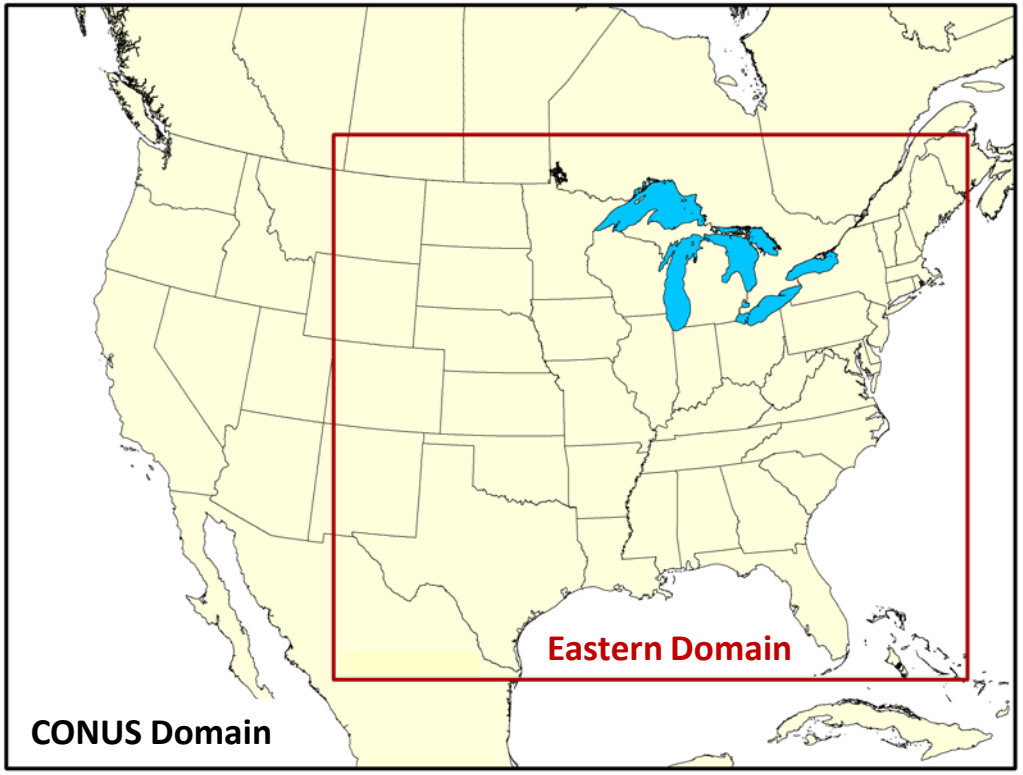
- CAIR court decision - 7/2008
- CAIR remand - 12/2008
- Transport Rule (proposal) - 7/6/2010
- Transport Rule/CSAPR (final) - 7/6/2011
- U.S. Court of Appeals D.C. Circuit issues stay 12/30/2011
- CSAPR vacated - 8/21/2012

Major Elements of the Cross State Air Pollution Rule

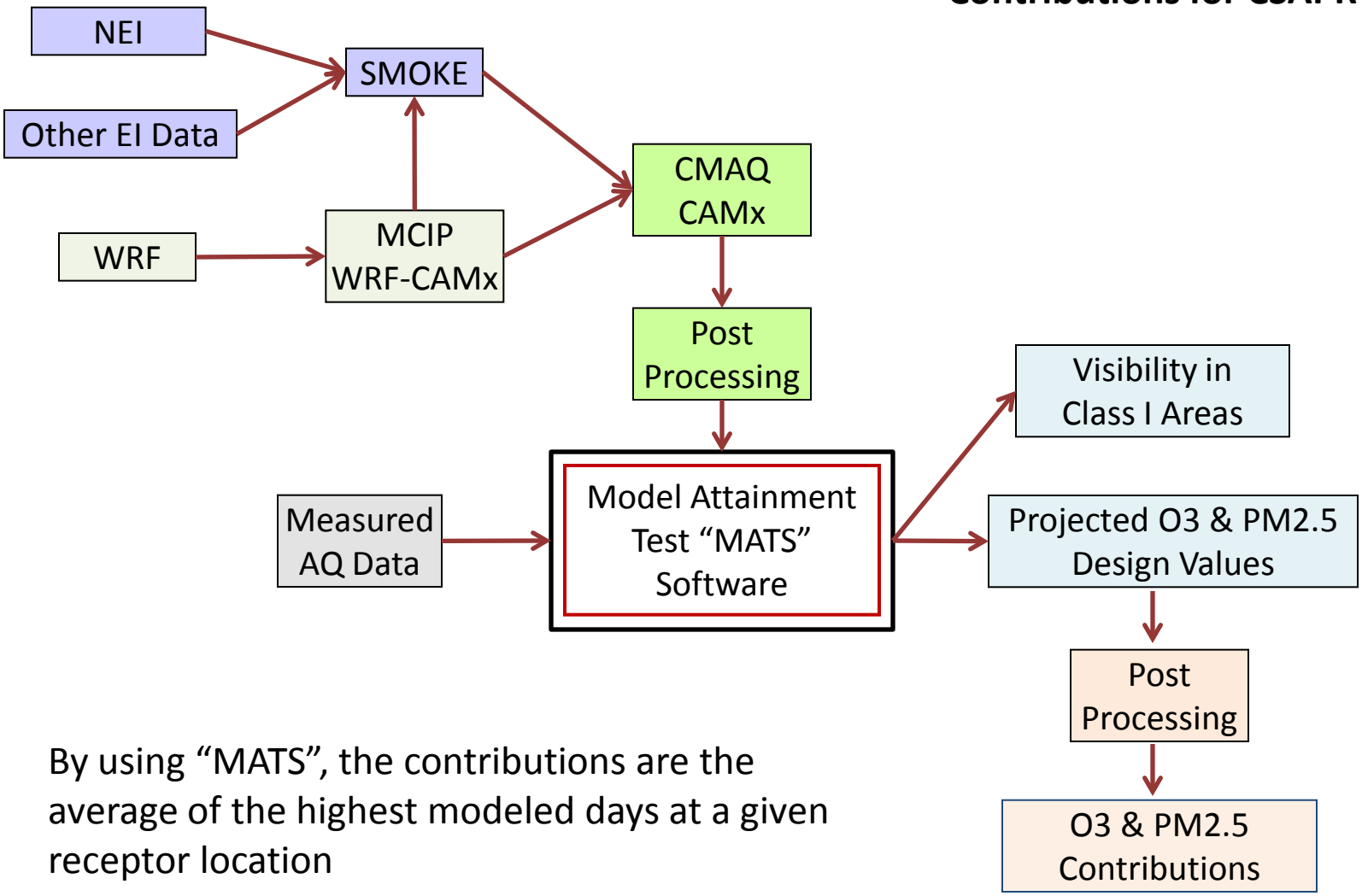
- Identify air quality "need" – areas in the Eastern US projected to have nonattainment/maintenance problems in the future
- Quantify interstate air quality contributions for annual and daily PM2.5 and 8-hour ozone in the East
- Use air quality thresholds to identify states to be covered by the rule
- Define/quantify the amount of significant contribution (emissions) to be eliminated (i.e. specify state emissions budgets)
- Structure of remedy
- Quantify the expected benefits of the rule

Air Quality Modeling for CSAPR

- Model/Domains/Met/Scenarios
  - CAMx v5.3
  - 12 x 12 km grid Eastern US domain nested within 36 x 36 km CONUS domain
  - Annual simulations using 2005 meteorology
  - Scenarios modeled
    - *2005 base year*
    - *2012 base case*
    - ***2012 base with source apportionment (12 km EUS only)***
    - *2014 base case*
    - *2014 remedy (control case)*



General Process for Estimating Contributions for CSAPR



By using "MATS", the contributions are the average of the highest modeled days at a given receptor location

Identify Future Nonattainment/ Maintenance Receptors

- Base year design values were projected to 2012 and 2014
  - Followed Modeled Attainment Demonstration guidance methodology
    - Modeling used to calculate % change in ozone or PM2.5 species between 2005 and 2012 or 2014 (relative response factor or RRF)
    - % change in ozone or PM2.5 species multiplied by base year ambient data
- Base year ambient design values taken from the period 2003-2007
  - Base model year is 2005; projected design value periods span 2005 (2003-2005, 2004-2006, 2005-2007)
  - Projected each of these periods and the 5-year weighted average
- Definition of Nonattainment and Maintenance
  - Future year projection of **average** design values used to determine nonattainment receptors
  - Future year projection of **maximum** design values used to determine maintenance receptors (maintenance considers variability due to meteorology and emissions)

2012 Nonattainment & Maintenance Receptor Sites

- Annual PM2.5
  - 12 nonattainment sites
  - 4 maintenance sites
- Daily PM2.5
  - 20 nonattainment sites
  - 21 maintenance sites
- 8-Hr Ozone
  - 7 nonattainment sites
  - 9 maintenance sites

Approach for Quantifying Ozone and PM2.5 Contributions

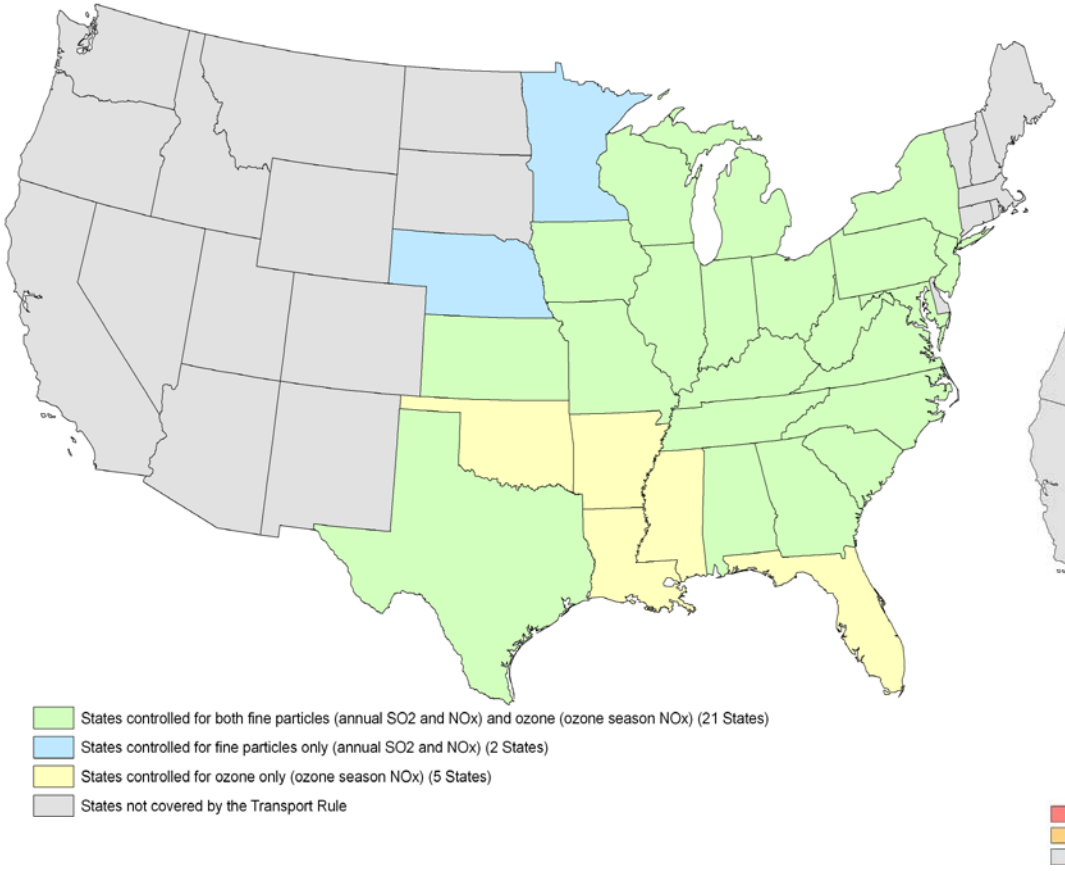
- CAMx source apportionment modeling performed for PM2.5 (PSAT) and ozone (APCA)
- Interstate contributions based on state total anthropogenic emissions in the 2012 base case
  - SO2 emissions -> sulfate
  - NOx emissions -> nitrate
  - NOx emissions -> ozone
- CAMx source apportionment outputs applied in a “relative sense” to calculate contributions
  - Contributions *from* each state *to* each receptor site
  - Receptor sites are nonattainment and maintenance monitors

States Covered by CSAPR

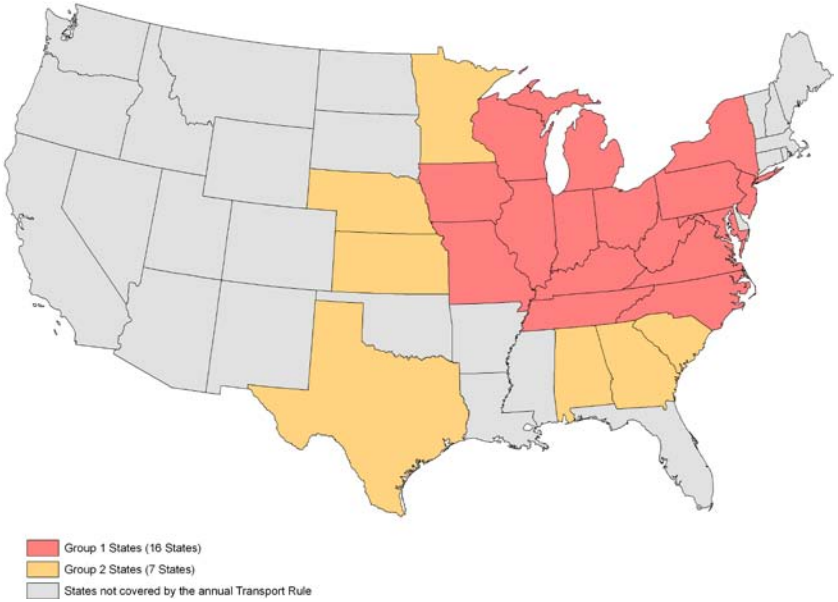
- Air quality contributions were evaluated against thresholds defined as 1 percent of the NAAQS
  - 8-hr Ozone (0.8 ppm 1997 NAAQS)
    - 0.8 ppb
  - Annual avg PM2.5 (15.0 µg/m^3 1997 NAAQS)
    - 0.15 µg/m^3
  - Daily average PM2.5 (35 µg/m^3 2006 NAAQS)
    - 0.35 µg/m^3
- States which contribute ozone and/or PM2.5 at or above the thresholds to 2012 nonattainment of maintenance sites in other (i.e., downwind) states are included in the rule
  - States that contribute at or above the thresholds to annual and/or daily PM2.5 (sulfate + nitrate) are included for annual SO2 and NOx budgets
  - States that contribute at or above the threshold for ozone are included for ozone season (May – Sept) NOx budgets

States Included in CSAPR

Total Program Coverage



Group 1 versus Group 2 SO_2 States



23 states are required to reduce both annual SO2 and NOx emissions.
26 states are required to reduce NOx emissions during the ozone season (May through September).

CSAPR Web Site

- www.epa.gov/crossstaterule/ for more info on CSAPR including…..
  - Regulatory Actions
  - Link to the TR/CSAPR docket
  - Air Quality Modeling TSD
  - Emissions Inventory TSD
  - Significant Contribution TSD
  - IPM-predicted EGU emissions
  - Ozone and annual and daily PM2.5 contributions from each state to each receptor site
  - Costs and Benefits of the rule

Challenges moving forward based on recent court decisions

Legal Context: Review from Webinar Transport Obligations and SIP Submissions

- Each state has an obligation to prohibit emissions that "significantly contribute to nonattainment" or "interfere with maintenance" of the NAAQS in another state
- Pursuant to *Homer City*, a state is not required to submit a 110(a)(2)(D)(i)(I) SIP until EPA defines its obligation under that provision
- EPA's transport rule must quantify states' 110(a)(2)(D)(i)(I) duties to trigger the SIP submission obligation
  - Under *Homer City*, EPA's role is to quantify each state's obligation and the state's role, in turn, is to satisfy that obligation as defined by EPA -- not to redefine or re-quantify the obligation

Outline of Steps for Addressing Transport

- Defining the obligation
  - Identify problem receptors (i.e., monitoring sites with nonattainment and/or maintenance problems)
  - Quantify the contribution from emissions in each upwind state to nonattainment/maintenance at downwind problem receptors
  - Determine upwind state responsibility (e.g., emission reductions or air quality improvements) consistent with the *Homer City* decision
    - Quantify each upwind state's proportional share with respect to each receptor, to ensure no upwind state is required to address more than its proportional share
    - If a screening threshold is used (e.g., in CSAPR the threshold was 1% of the NAAQS), ensure no state is required to reduce its emissions below that threshold
    - Consider whether individual state's obligations should be further lowered based on cost considerations
    - Evaluate whether collective reductions would result in unnecessary over-control and, if so, attempt to minimize it
- Once the obligation is defined, implementation requires:
  - Additional SIP regulations to provide enforceable mechanism to satisfy state obligation