

Single Source Modeling Overview

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Note

- All information presented is considered preliminary by the U.S. EPA and provided to describe and illustrate potential approaches and complex ideas
- This work is evolving and we are continuing to learn and improve these techniques so some or all of the information presented in this presentation and in this session may change

Fine Scale/Single Source Modeling

- Table below shows model scales, application types, and example models currently used for these needs (not all models shown)
- Evaluate models consistently against available observation data and in the context the models will be applied

Application type and scale	SO₂, NO₂, Primary PM_{2.5}	Secondary PM_{2.5}	Ozone
Single source fenceline	AERMOD		
Single source urban scale	AERMOD		
Hybrid single source/all sources "hot spot" analysis			
All sources urban scale	CAMx, CMAQ	CAMx, CMAQ	CAMx, CMAQ
All sources urban to regional scale	CAMx, CMAQ	CAMx, CMAQ	CAMx, CMAQ
Single source long range transport assessments	CALPUFF	CALPUFF	
All sources regional to continental scale	CAMx, CMAQ	CAMx, CMAQ	CAMx, CMAQ

Focus Areas

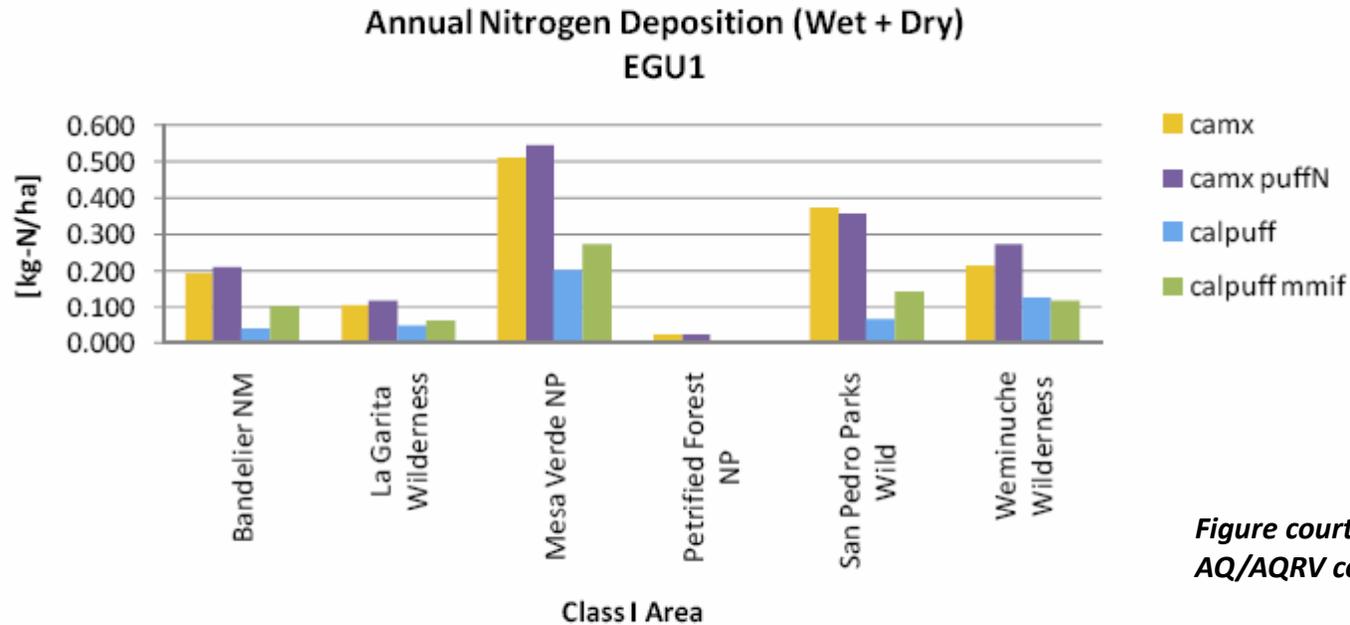
- Single source modeling of long range transport
 - Ozone, PM2.5, deposition at Class I areas for PSD and NSR programs
- Single source modeling on urban scale
 - Ozone and PM2.5 (maybe visibility in the future) impact assessments for PSD and NSR programs

Single Source – Long Range Transport

- Long range transport of ozone and PM2.5 (air quality or AQ) and deposition (air quality related values or AQRVs) to Class I areas for PSD/NSR assessments
- Looking at existing and alternative modeling systems for long range transport assessments of PM2.5, AQRVs, and ozone
- ENVIRON developed a new program, MMIF, to convert WRF or MM5 output directly to CALPUFF, SCICHEM, and AERMOD (beta release of the MMIF tool in February 2012)
- AQMG team actively supporting the MMIF tool along with ENVIRON
- Currently working with other Federal Agencies (USFS), contractors (ENVIRON/UNC) and internally to evaluate and compare modeling systems

Single Source – Long Range Transport

- ENVIRON report evaluating Lagrangian and photochemical model long range transport against regional tracer release experiments in U.S. and Europe: CALPUFF, SCIPUFF, CAMx, HYSPLIT, FLEXPART
- ENVIRON developing a modeling system comparison report for single source AQ & AQRV assessments using Lagrangian and photochemical models: CALPUFF, SCICHEM, and CAMx



*Figure courtesy of ENVIRON
AQ/AQRV comparison report*

Single Source – Urban scale

- Need near field plume chemistry to estimate single source impacts on ozone and secondarily formed PM2.5 for PSD & NSR programs
 - Currently AERMOD is used to assess impacts of directly emitted PM2.5
- EPA granted Sierra Club petition with commitment to update Appendix W to address O3 and secondary PM2.5 impacts
- Develop modeling guidance for assessing single source impacts on secondary pollutants such as ozone and PM2.5
- NACAA recently recommended a 4-tier approach to PM2.5 impact assessments for PSD/NSR
- Need for technical basis to establish interpollutant trading ratios for PM2.5 to inform NSR offsets and SIP measures

Single Source – Urban scale

- NACAA recommendation of a multi-tier approach to assessing single source impacts of PM2.5 (did not address ozone)
 - Use AERMOD for primary PM2.5 with offset ratios to approximate secondary PM2.5; location specific offset ratios difficult to estimate
 - Use a Lagrangian model with plume chemistry (CALPUFF or SCICHEM)
 - Use a photochemical modeling system (CAMx or CMAQ)
 - Brute force emissions sensitivity
 - Direct decoupled method (DDM)
 - Source apportionment
 - Sub-grid plume treatment
- Currently working with other Federal Agencies (USFS), contractors (ENVIRON/UNC) and internally to evaluate and compare modeling systems
- OAQPS/AQAD/AQMG needs to understand how these different approaches are comparable and how best to apply models for this purpose to develop guidance and review future permits

Single Source – Urban scale

- **Investigating the feasibility and utility of a screening level tool** (reduced form model) to provide a quick, reasonable, and credible assessment of single source secondary impacts before full-scale photochemical model application is needed
- When are Lagrangian puff/particle models appropriate?
- Need to determine when screening vs. photochemical model assessment is appropriate (e.g., inform updated SERs and SILs under NSR/PSD)
- **Need to understand the most appropriate ways to apply a photochemical model to assess the impacts of single sources for permitting purposes**

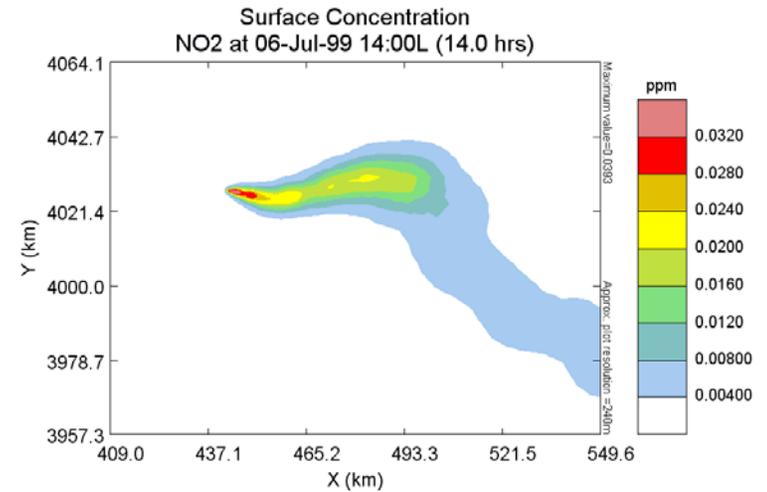
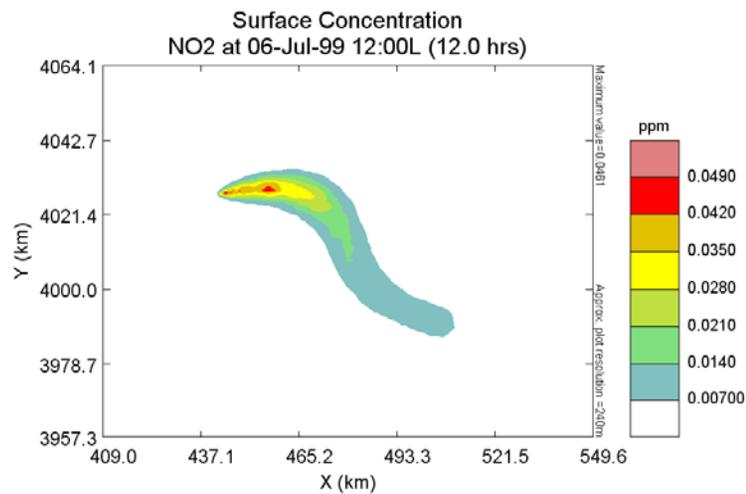
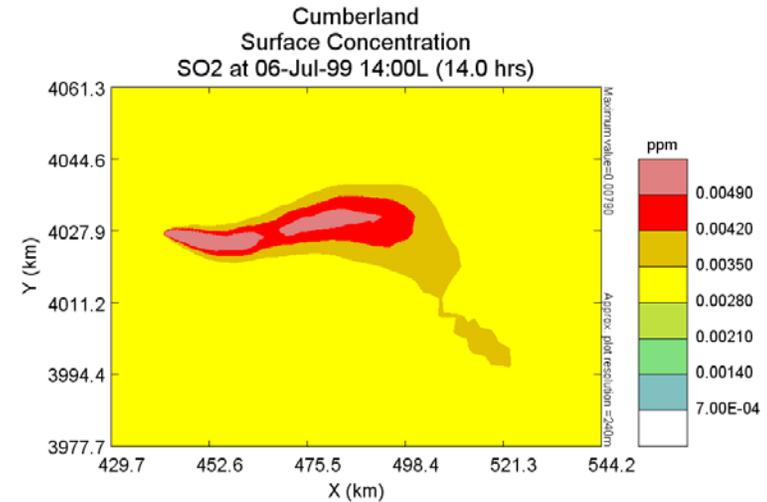
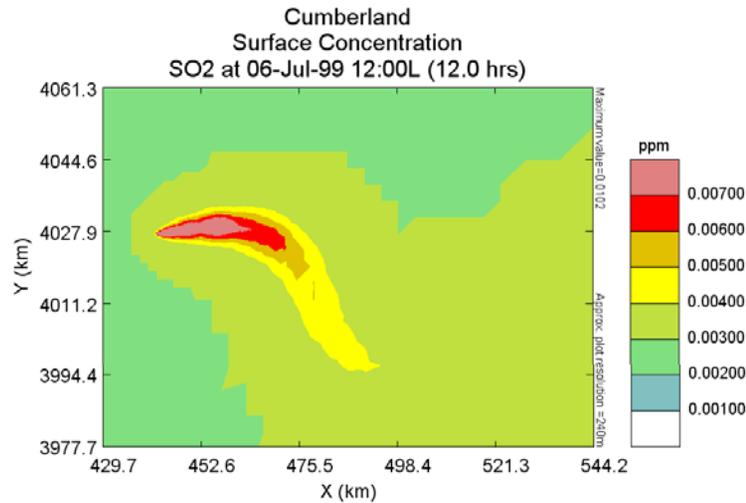
Single Source Screening Level Tool

- ENVIRON presented a reduced form single source screening model that estimates ozone impacts from single source emissions of VOC and/or NOX based on CAMx-HDDM
- This approach may fill a need for a technically sound screening tool to efficiently evaluate which sources would require more rigorous modeling
- AQMG plans to explore this approach for ozone and PM2.5 to support single source NSR/PSD screening assessments
 - use either CAMx or CMAQ with higher order DDM for ozone and DDM for PM2.5
- This modeling may provide some information for developing appropriate interpollutant trading ratios for PM2.5

Single Source Modeling

- Currently finishing 3 reports being compiled by ENVIRON
 - Documentation of the Evaluation of CALPUFF and Other Long Range Transport Models using Tracer Field Experiment Data
 - Comparison of Single-Source Air Quality Assessment Techniques for Ozone, PM2.5, other Criteria Pollutants and AQRVs
 - Evaluation of Chemical Dispersion Models using Atmospheric Plume Measurements from Field Experiments
- SCICHEM exploration and application by AQMG (J. Kelly)
 - 1999 TVA field experiment
- Comparison of AQ estimates using a variety of photochemical modeling systems and approaches
 - 1999 TVA field experiment

Preliminary SCICHEM results (J. Kelly): SO2 concentrations from Cumberland (top row) and NO2 concentrations (bottom row)

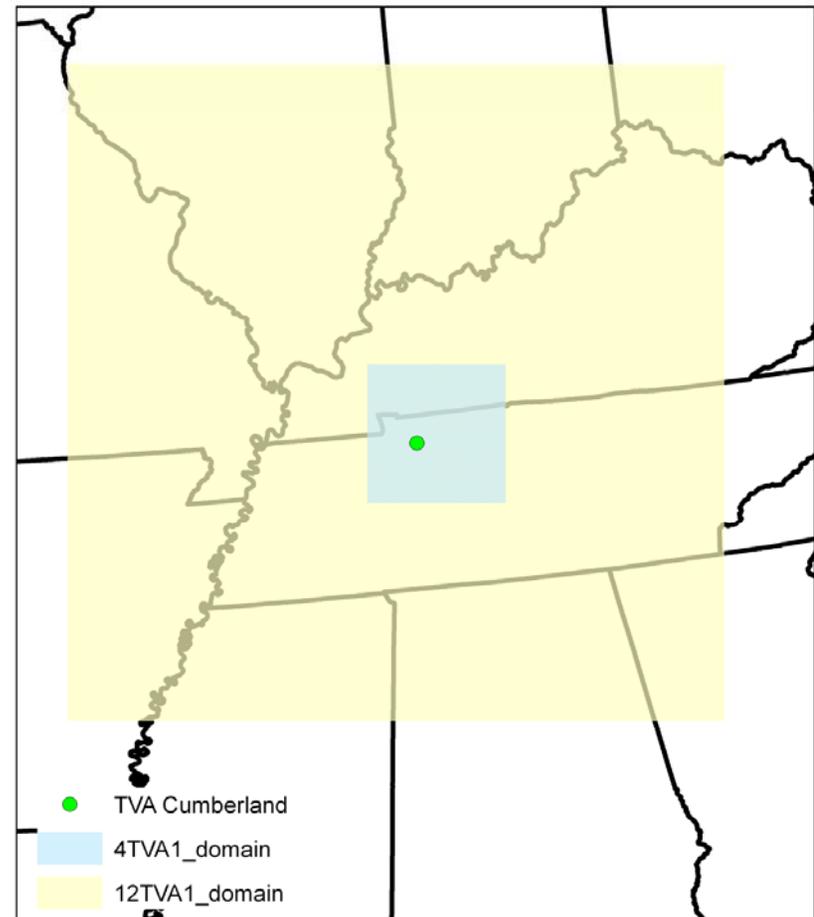


Single Source Modeling

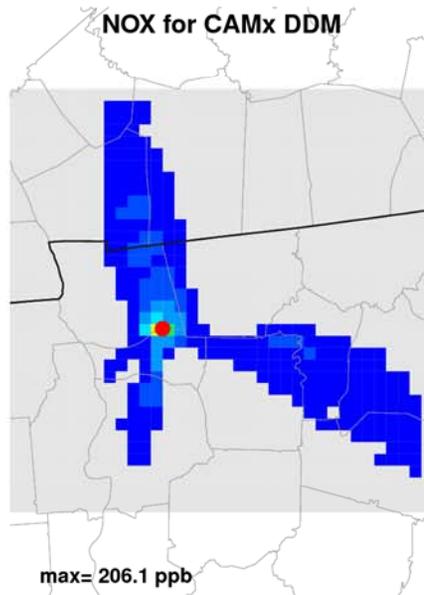
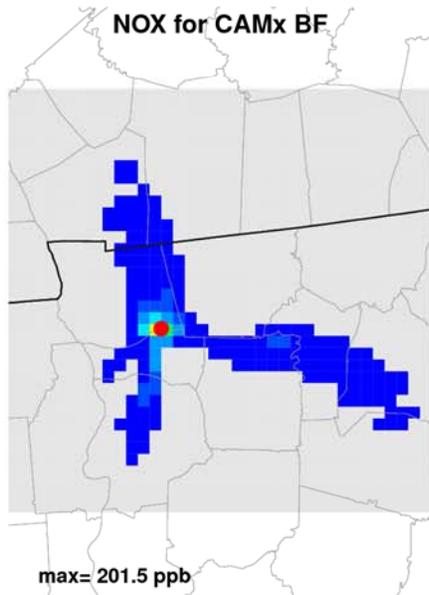
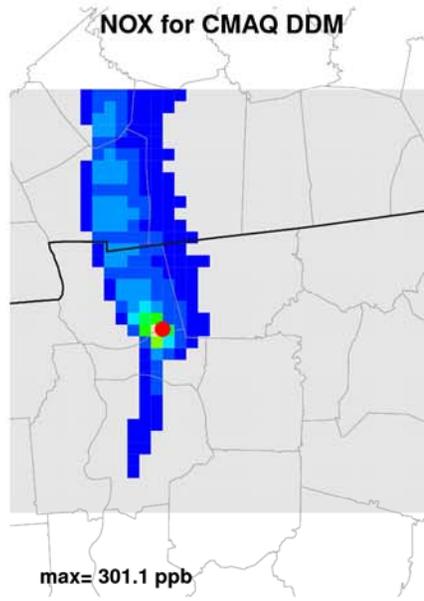
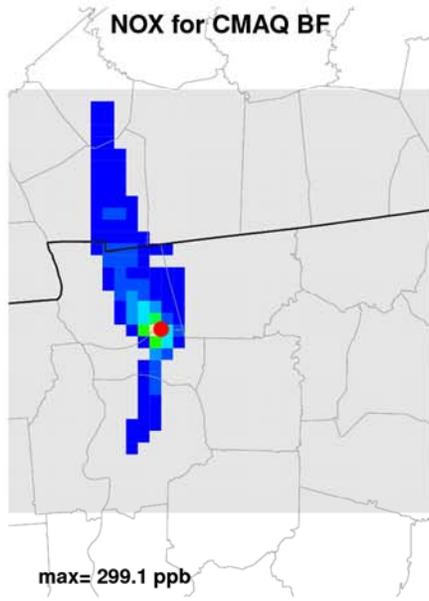
- Application of photochemical modeling systems for single source O₃ and PM_{2.5} assessments using a plume measurement field study (1999 TVA)
- CMAQ and CAMx brute force and DDM emissions sensitivity
- CAMx source apportionment
- When available, CMAQ source apportionment
- CAMx flexi-nesting
- CAMx sub-grid plume treatment
- When available, CMAQ sub-grid plume treatment (APT approach developed by EPRI)

Modeling Setup

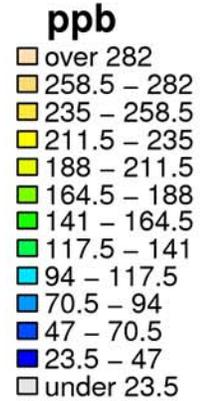
- 1999 hour specific CEM emissions for TVA Cumberland
 - <http://camddataandmaps.epa.gov/gdm/index.cfm?fuseaction=emissions.wizard>
- 1999 hour specific biogenics estimated with BEIS model
- 2001 NEI based anthropogenic emissions
- Meteorological inputs generated using the WRF model version 3.3
- Photochemical models used: CMAQ v.4.7.1 and CAMx v5.40
- Domains: 36 km CONUS, 12 and 4 km; 34 vertical layers



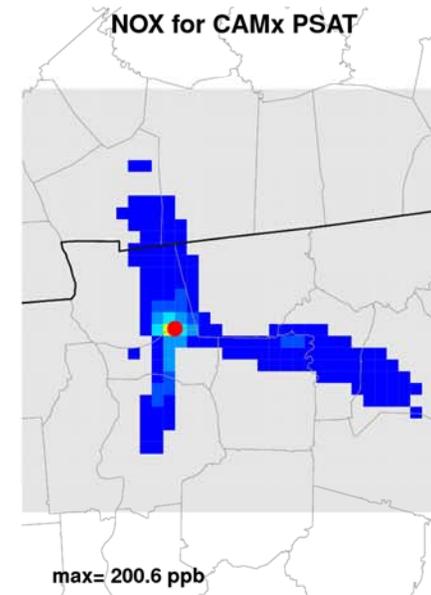
2 week (July 1999) episode maximum impact of NOX (NO+NO2) from source



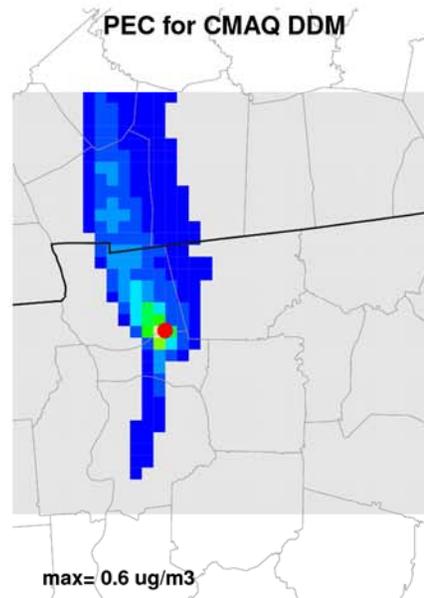
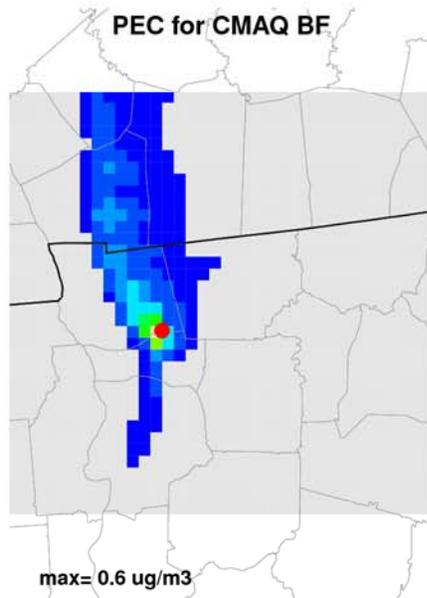
*CMAQ source apportionment in development by ORD



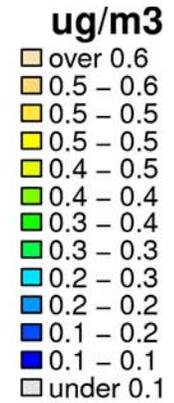
**red dot indicates source location*



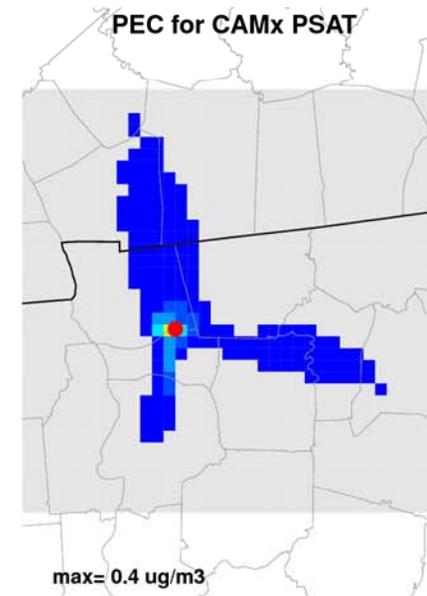
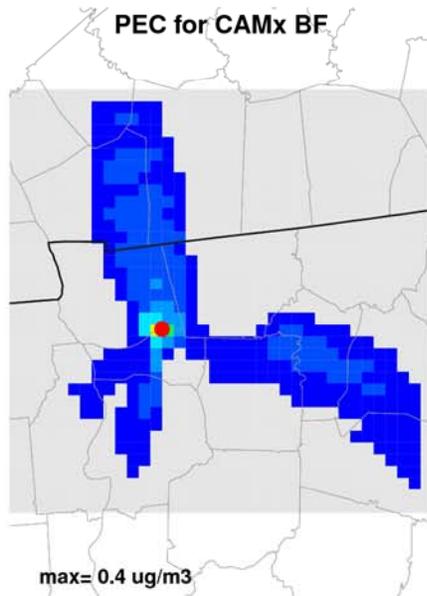
2 week (July 1999) episode maximum impact of elemental carbon from source



*CMAQ source apportionment in development by ORD



*red dot indicates source location



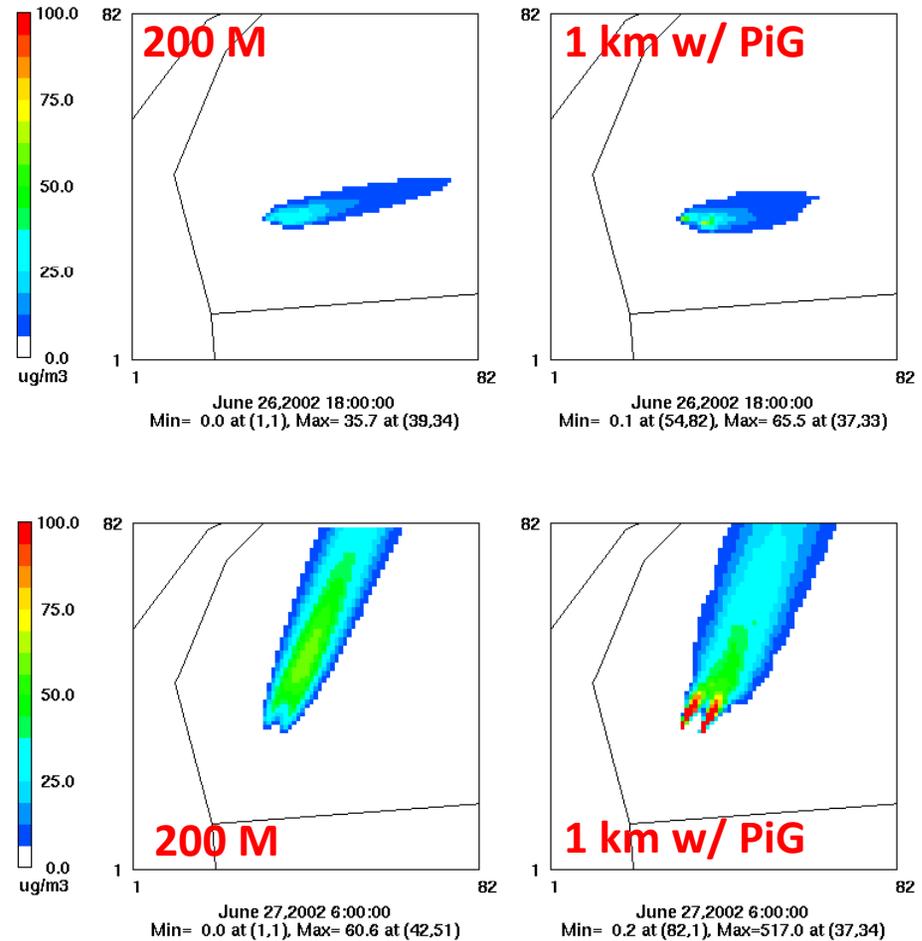
Source – Receptor Proximity Issues

- Source-receptor spatial relationships are sometimes not resolved at 1 km
 - In Figure below (from Illinois EPA), the source is outlined in green and the receptor is labeled 'A' (the meteorological station is labeled 'B')
- Modeling system and sub-grid plume evaluation work critical for appropriate modeling guidance for these situations



Source – Receptor Proximity Issues

- Local area analysis often necessary in areas that are not modeling attainment due to the influence of nearby sources to particular monitors not being resolved at 4 to 12 km
- Fence-line or near fence-line impact assessments for permits
- Modeling system and sub-grid plume evaluation work will lead to improved modeling guidance for these situations
- How to track source contribution using these techniques?
- How best to configure sub-grid plume treatments?



**Graphics from Illinois EPA*