EPA/FLM Single Source LRT Demonstration Project

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Outline

- Discuss use of models for AQ/AQRV under NEPA
- Discuss design elements of the EPA/FLM single source model evaluation project
- Examine initial results of the evaluation project
- Discuss practical considerations of use of Eulerian models more routinely in a regulatory framework

NEPA Requirements and the FLM's

- Air quality modeling for NEPA was well defined
  - AERMOD for near-field analyses
  - CALPUFF for far-field
- …And then our monitors started to find problems
  - Winter ozone in Upper Green River Basin in Wyoming and Uinta Basin in Utah
- We now had to address ozone air quality modeling for pollutants that occurred in times of the year and in remote locations that were once considered only urban, summertime issues.

The Experience of the Multi-Use Land Management Agencies

- Multiple use land management agencies such as the Bureau of Land Management (BLM) and US Forest Service (USFS) are responsible for developing environmental impact statements (EIS') for any resource management decisions that are made for federal lands.
- For air quality, this means we must analyze potential impacts to local both local and regional air quality for each resource management option that is considered. This translated into running:
  - AERMOD for near-field NAAQS/increment analysis
  - CALPUFF for far field NAAQS/increment and AQRV
  - CAMx/CMAQ for ozone NAAQS

The FLM Experience (*continued*)

- The complexity and the cost associated with meeting the needs of air quality analyses under NEPA have grown considerably in the last five years.
- In response, USDA, DOI, and USEPA entered into a memorandum of understanding outlining generally agreed upon procedures for conducting air quality analyses. Principals of the MOU are to:
  - Establish agreed upon procedures for conducting air quality analyses, formal stakeholder input process, and dispute resolution procedures
  - Reduce the costs to both agencies and development project proponents through promotion of modeling techniques which allow for leveraging existing analysis to the extent practical
- Reduction of the burden in modeling can occur through two approaches:
  1. Establishing a reusable modeling framework – regional air quality analyses that bracket development potential in a given airshed that can be leveraged to describe potential impacts for an individual project
  2. Promoting use of single modeling platforms to the extent practical to deal with ozone and $PM_{2.5}$ NAAQS and AQRV requirements of NEPA.

Where Does EPA and FLM's Go From Here?

- NEPA requirements and Sierra Club petition necessitate that both FLM's and EPA reassess the suitability of the existing modeling paradigm to
- In order to address these needs, the EPA and FLM's undertook a project to compare the model predictions of existing models and emerging models to understand both the predicted impacts for resource management decisions and to better understand the resource requirements and challenges to implementation.

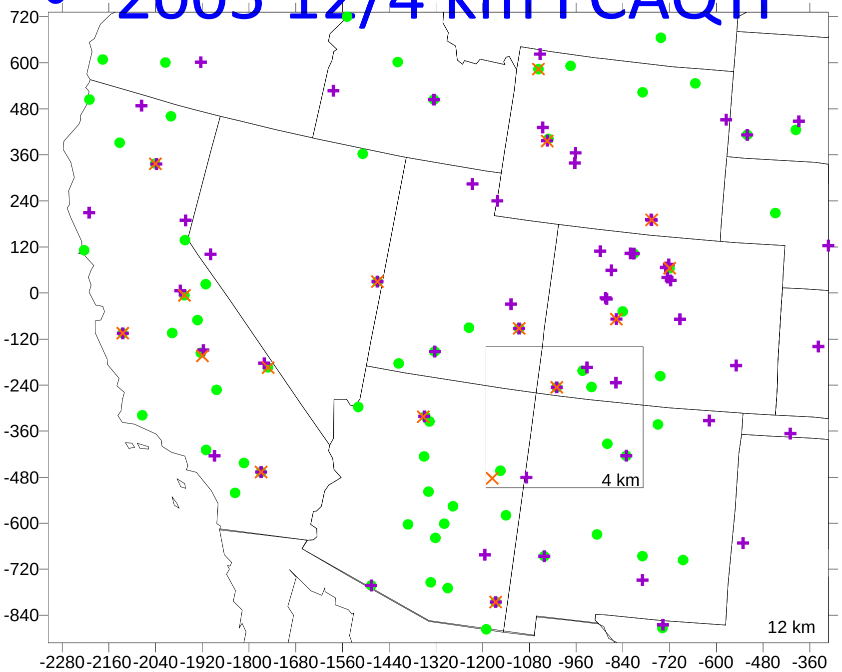
EPA WA Task 6:
Single-Source LRT Demonstration

- Apply LRT chemical dispersion models for example test sources as one would for a PSD far-field Class I assessment
  - 2005 and 2006 annual simulations examined
  - CALPUFF/CALMET and CALPUFF/MMIF
  - CAMx using PSAT/APCA source apportionment
- Compare far-field air quality and air quality related values (AQRVs) metrics at Class I areas across LRT dispersion models
  - Maximum concentrations SO2, NO2, PM10)
  - Maximum visibility impairment (FLAG, 2010)
  - Maximum sulfur and nitrogen deposition

- This presentation documents LRT dispersion model simulations and consequence analyses <u>performed by ENVIRON under contract to EPA</u> in 2011.

Task 6: Single-Source LRT Model Demonstration

- 2005 12/4 km FCAQTF



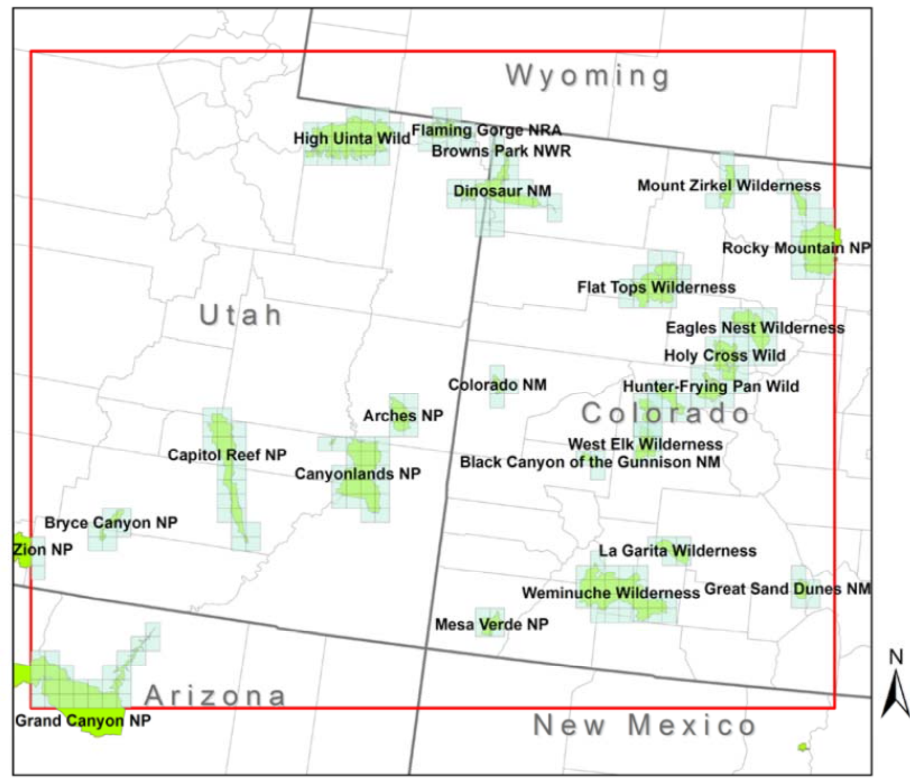
New Mexico CAMx 12 km Nested Domain

● IMPROVE
× CASTNET
+ NADP

CAMx 12 km: 167 x 137* (-2316, -912) to (-312, 732)
CAMx 04 km: 101 x 92* (-1192, -508) to (-788, -140)

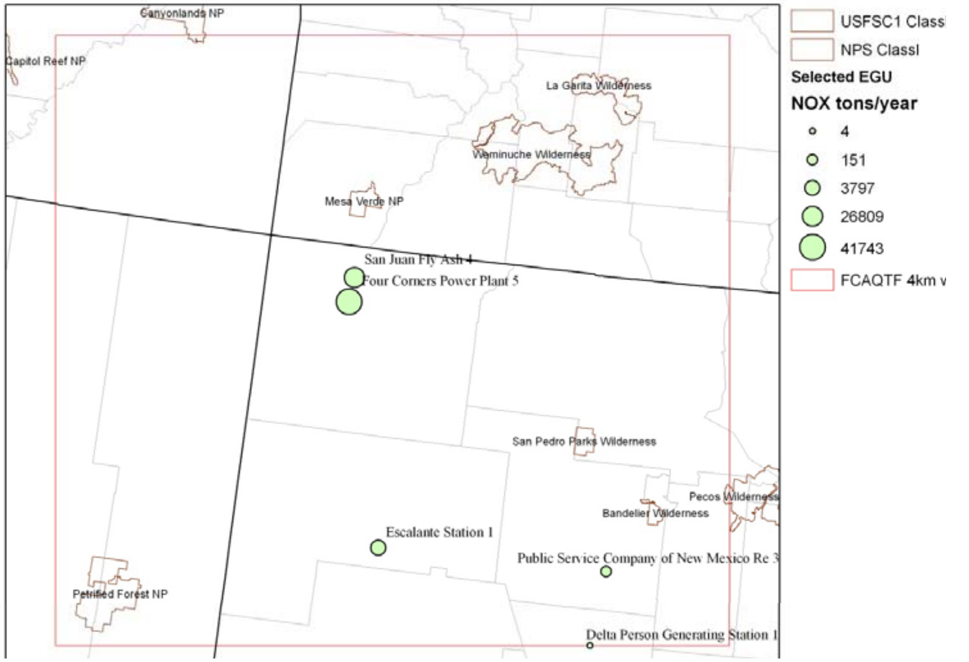
* includes buffer cells

- 2006 12 km UT-CO

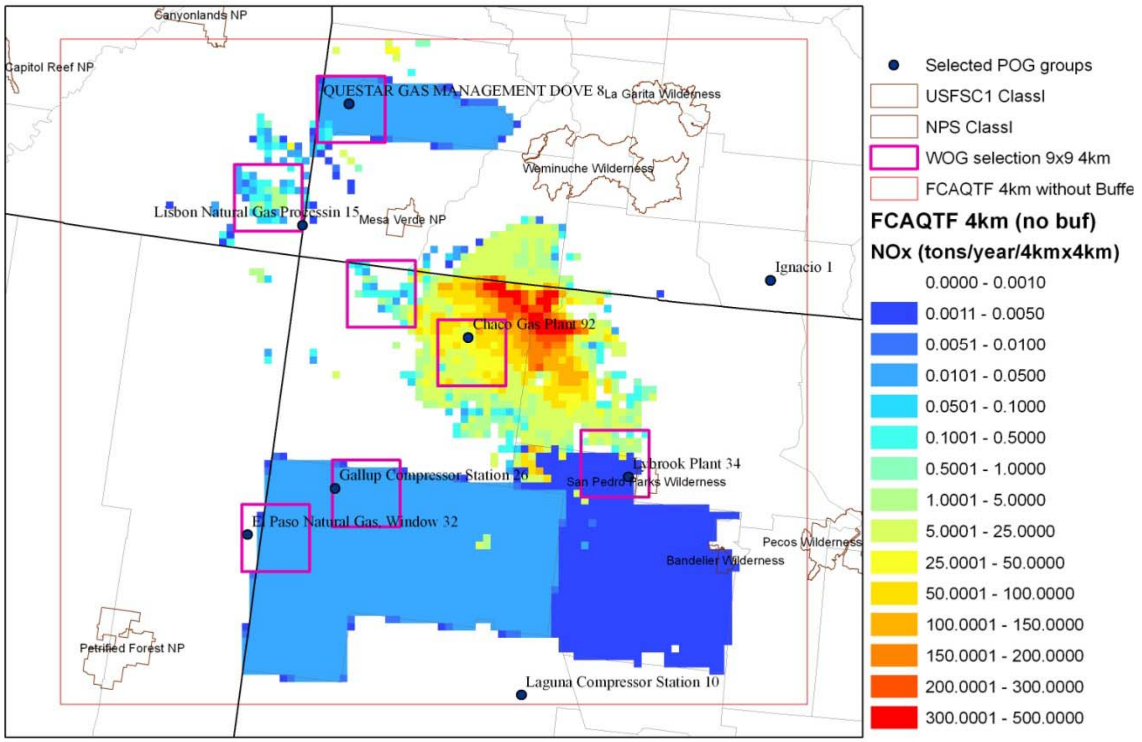


Test Sources
2005 FCAQTF 12/4 km

- 5 EGU Point Sources →

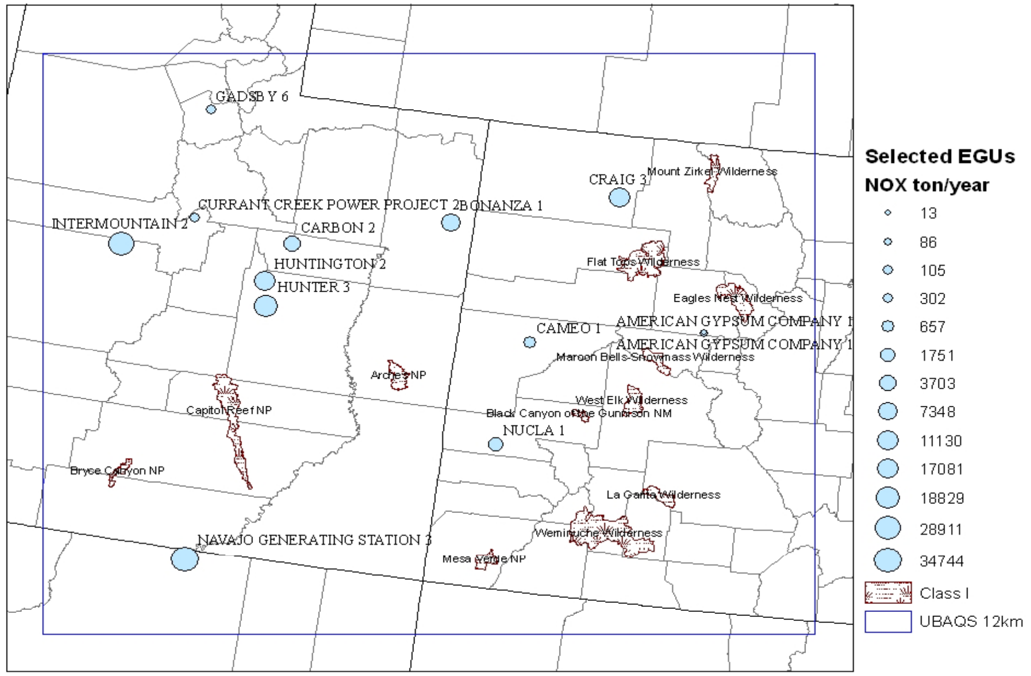


- 9 oil and gas point and area source areas→
  - 9 x 9 4 km area sources
  - Any point sources in region

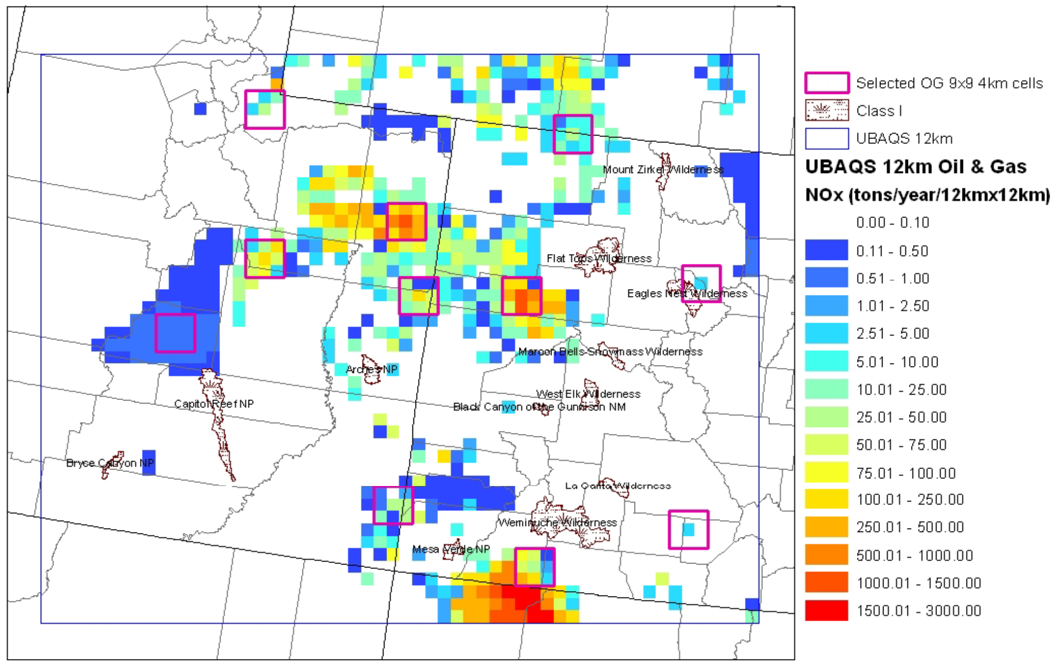


Test Sources
2006 12 km UT-CO

- 13 EGU Point Sources →

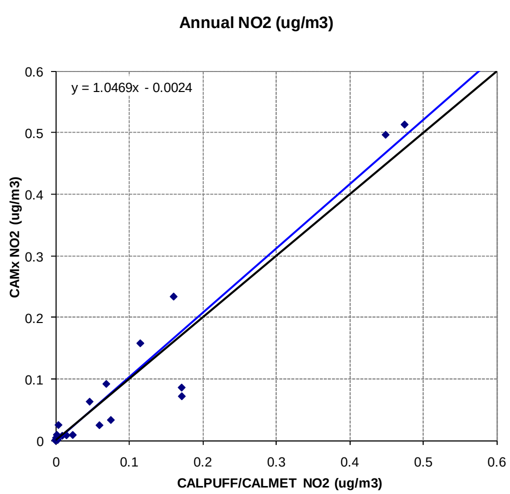


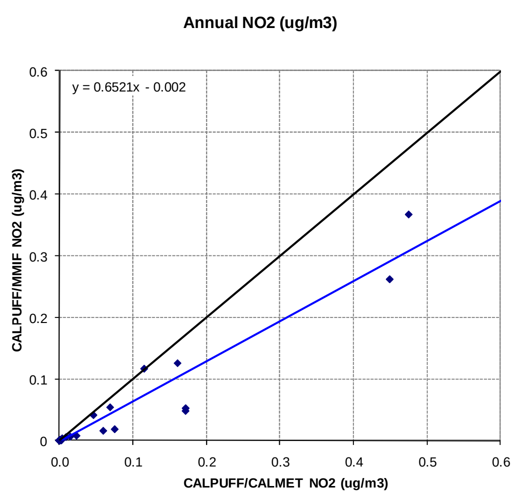
- 11 oil and gas point and area source areas→
  - 3 x 3 12 km grid cells
  - Any point sources in region

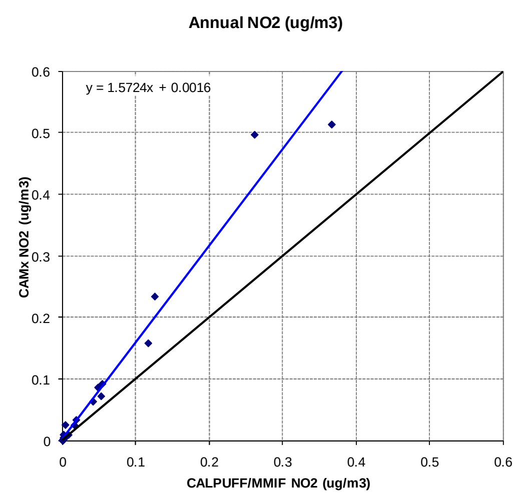


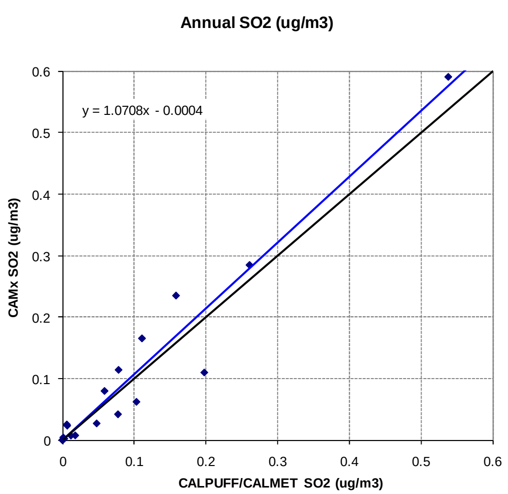
2005 4 km Annual NO2 (top) and SO2 (bottom) at Class I receptors: FCAQTF

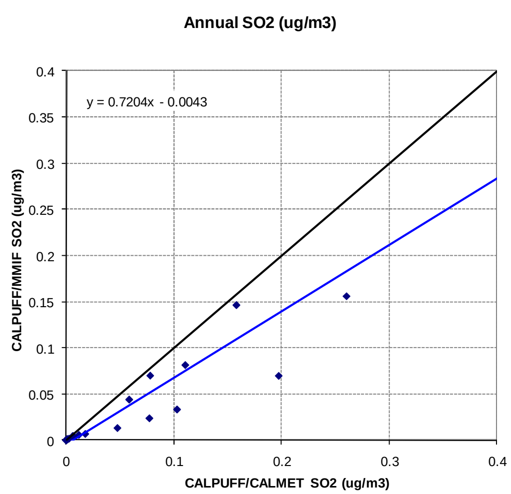
CALPUFF/CALMET vs. CAMx | **CALPUFF/CALMET vs. CALPUFF/MMIF** | **CAMx vs. CALPUFF/MMIF**

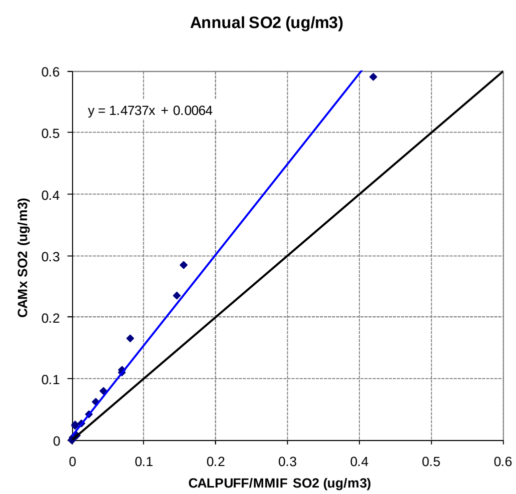






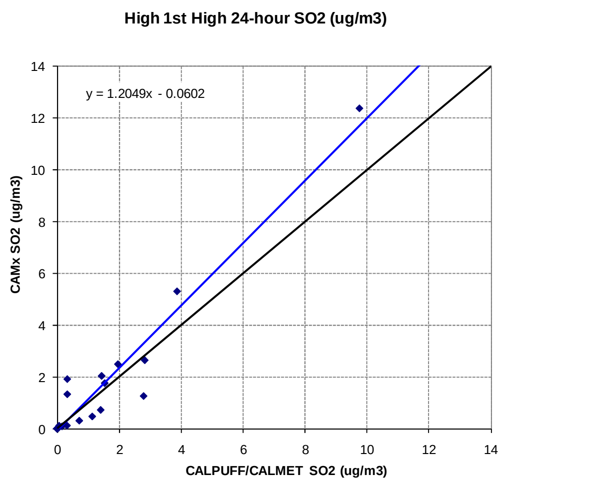


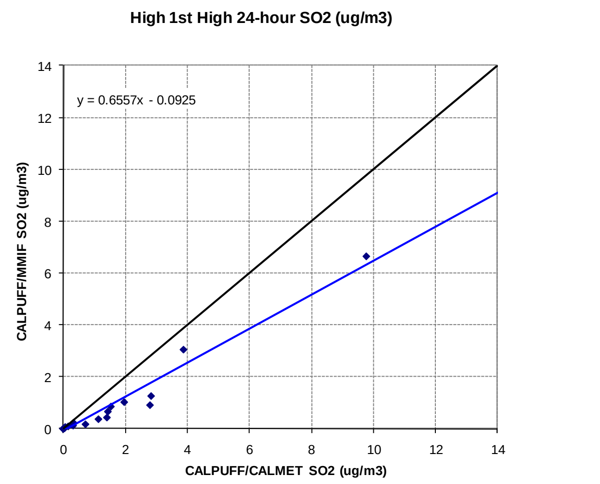


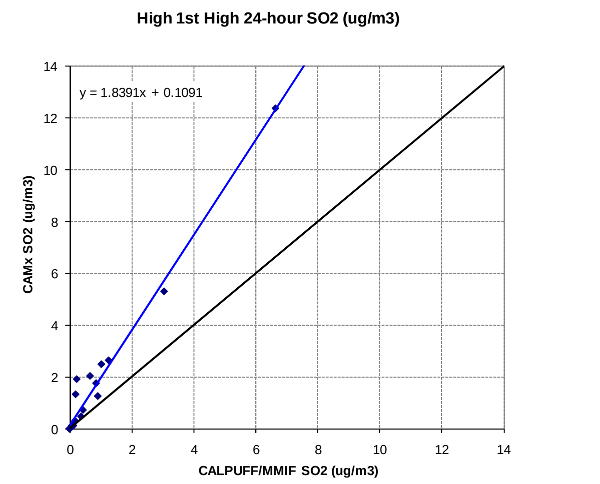


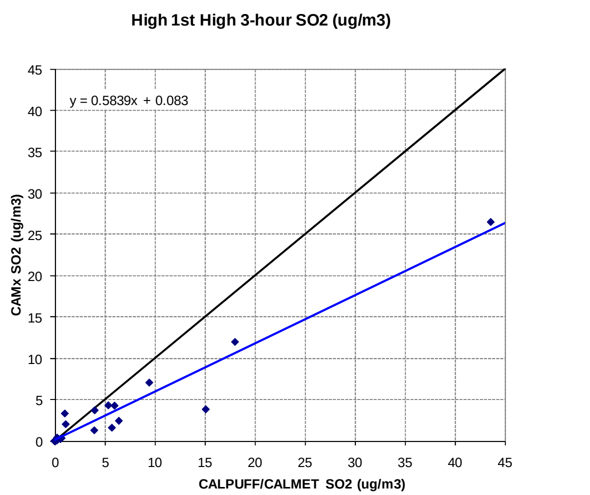
2005 4 km 24-hr (top) and 3-hr (bottom) SO2 at Class I receptors: FCAQTF

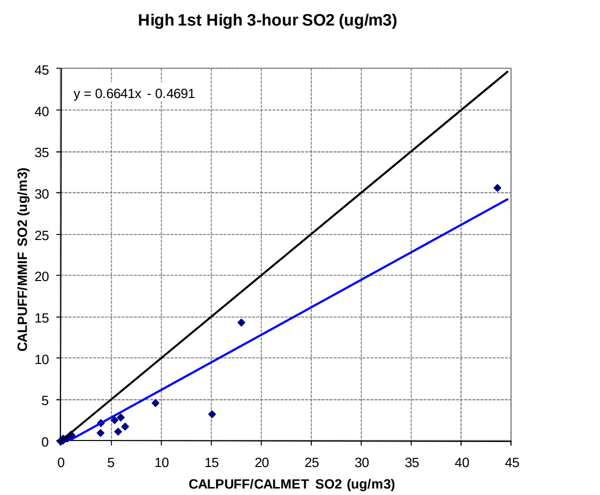
CALPUFF/CALMET vs. CAMx	CALPUFF/CALMET vs. CALPUFF/MMIF	CAMx vs. CALPUFF/MMIF

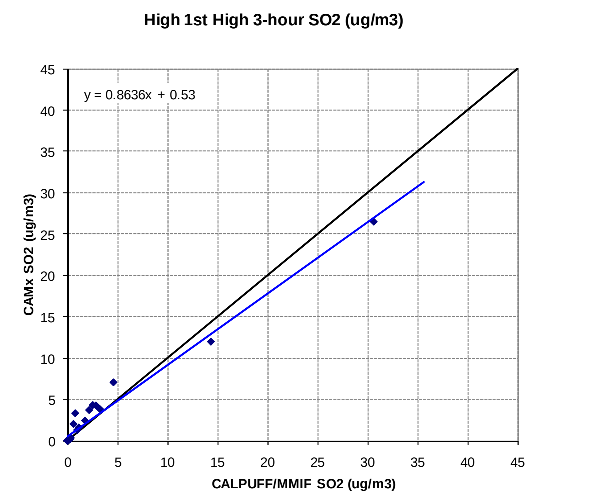




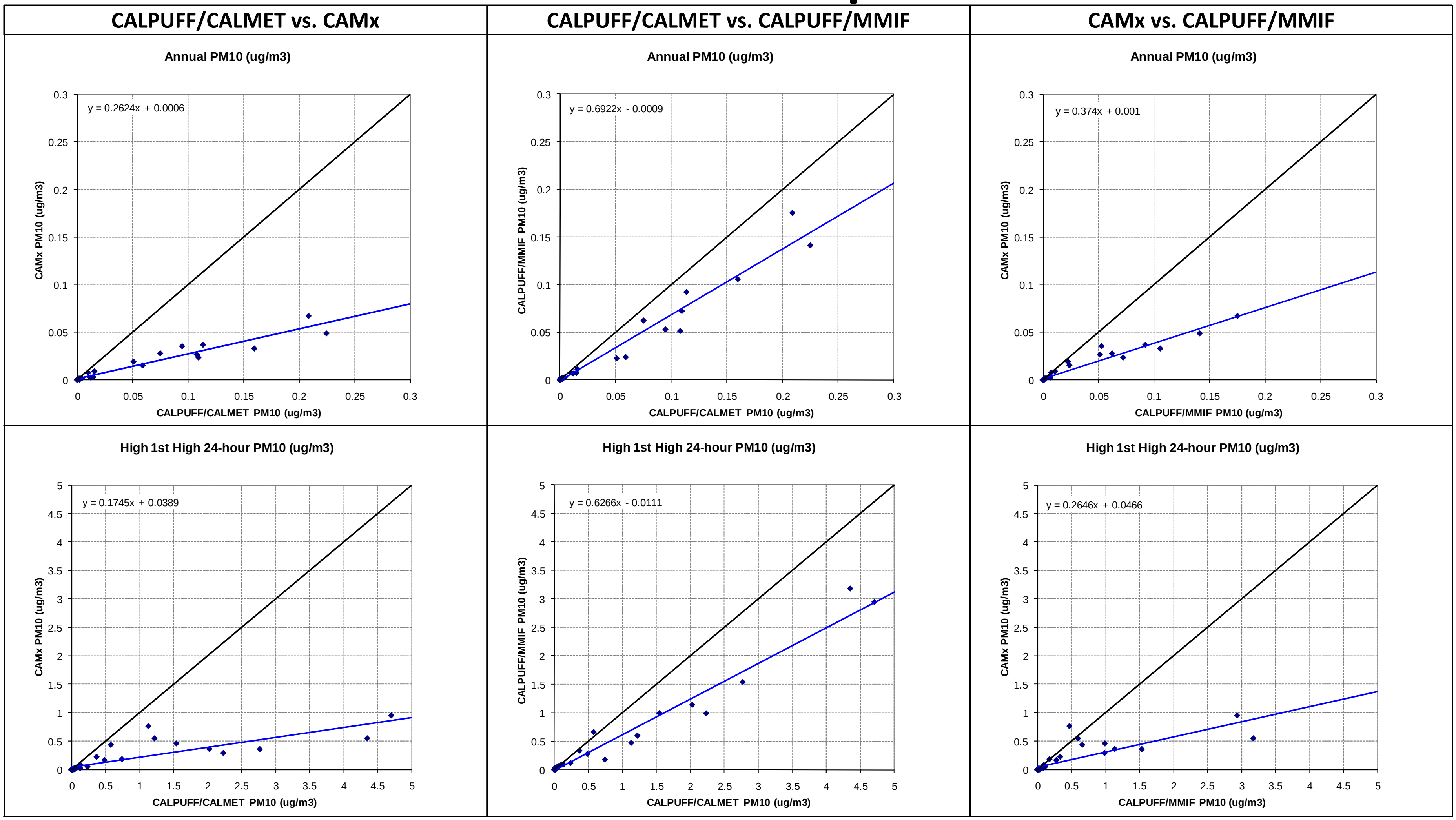








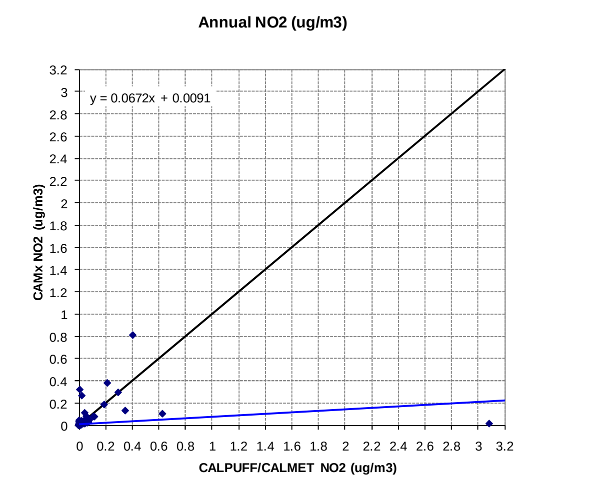
2005 4 km ann (top) and 24-hr (bottom) PM10 at Class I receptors: FCAQTF

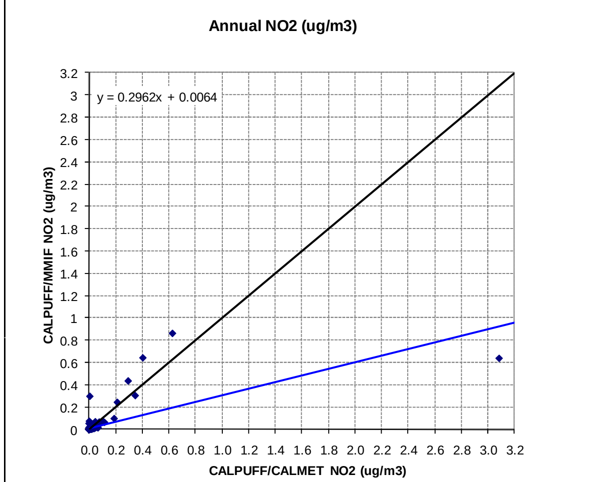


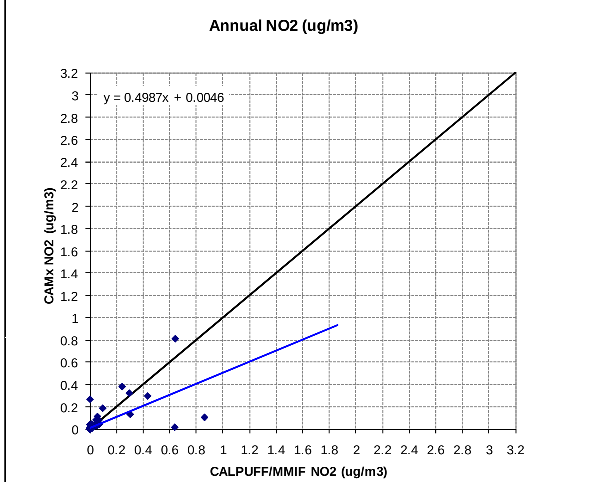
Different PM10 species mappings used w/ CALPUFF vs. CAMx/PSAT

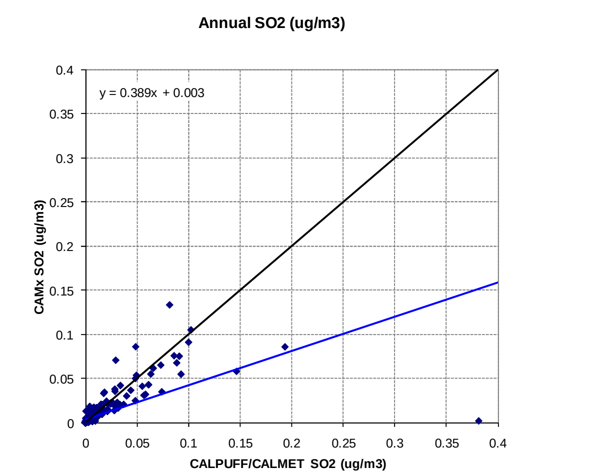
2006 12 km annual NO2 (top) and SO2 (bottom) at Class I receptors: UT-CO

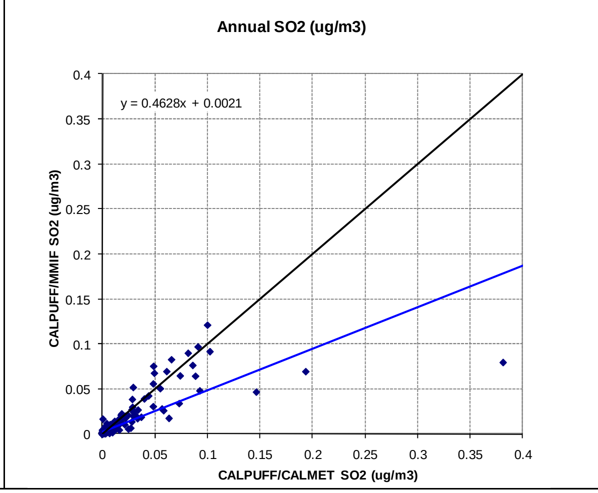
CALPUFF/CALMET vs. CAMx	CALPUFF/CALMET vs. CALPUFF/MMIF	CAMx vs. CALPUFF/MMIF

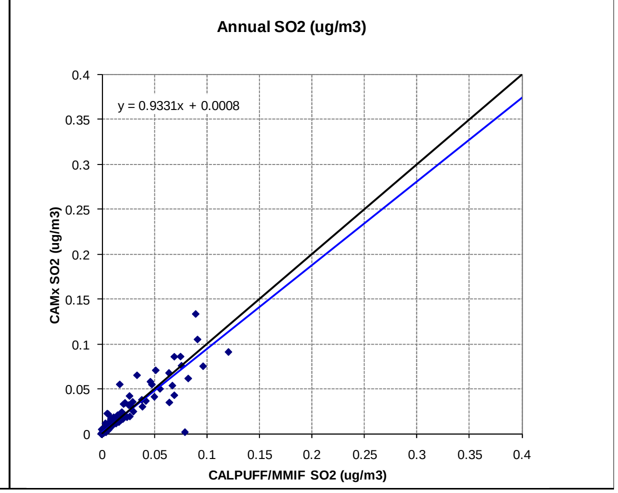








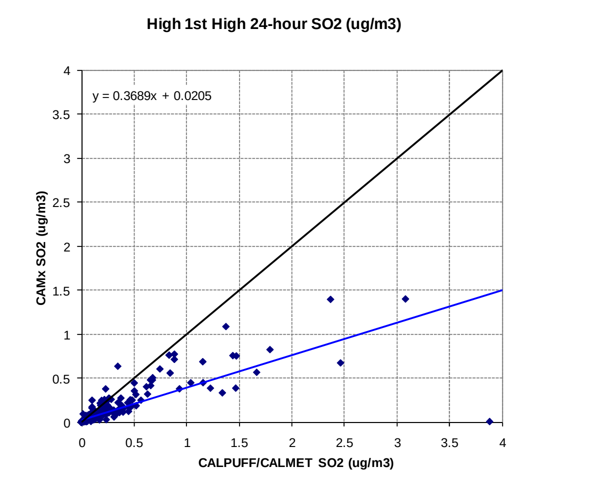


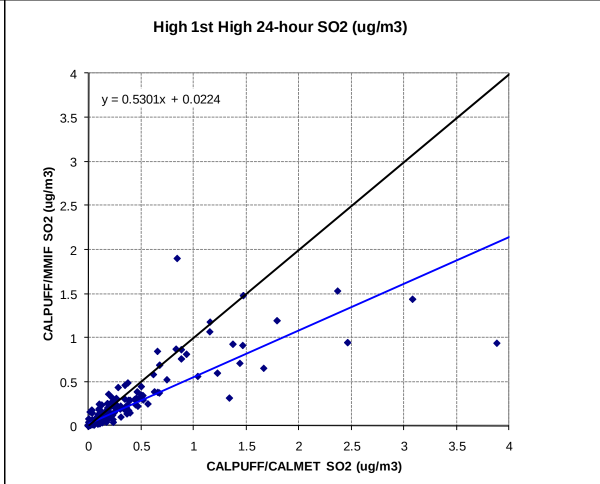


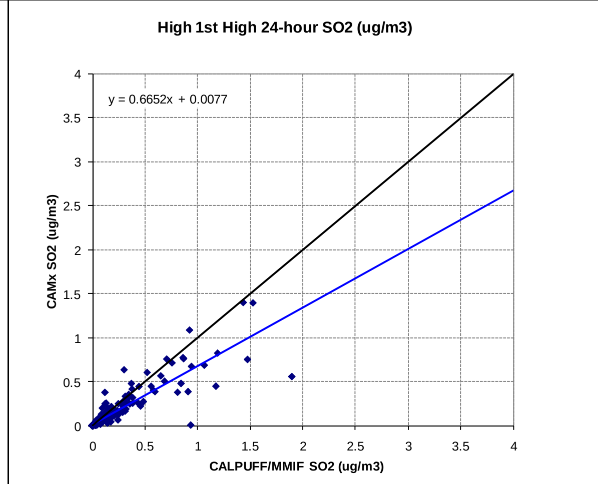
Very high CALPUFF/CALMET (CALPUFF/MMIF) outlier

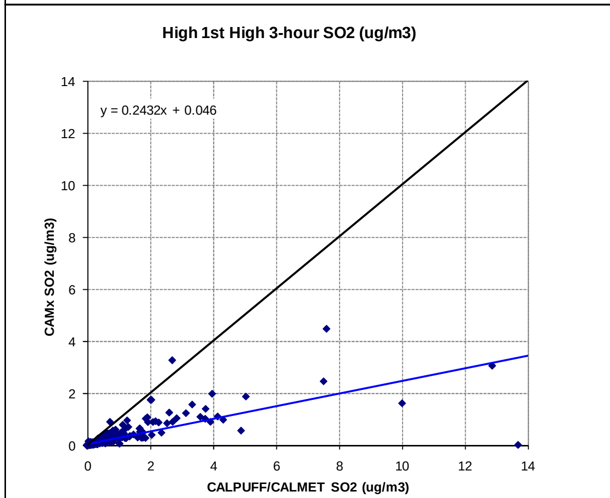
2006 12 km 24-hr (top) and 3-hr (bottom) SO2 at Class I receptors: UT-CO

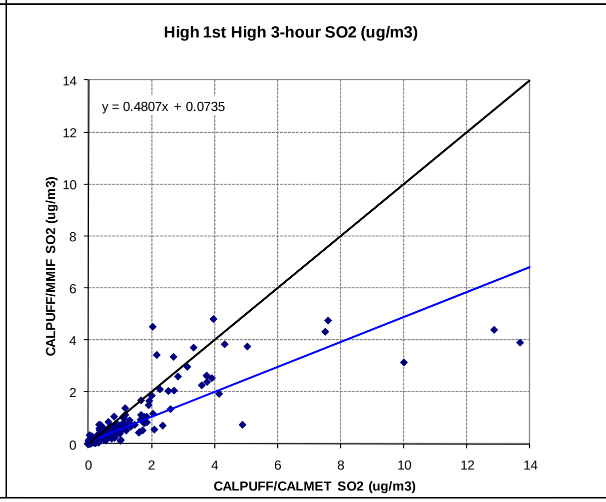
CALPUFF/CALMET vs. CAMx	CALPUFF/CALMET vs. CALPUFF/MMIF	CAMx vs. CALPUFF/MMIF

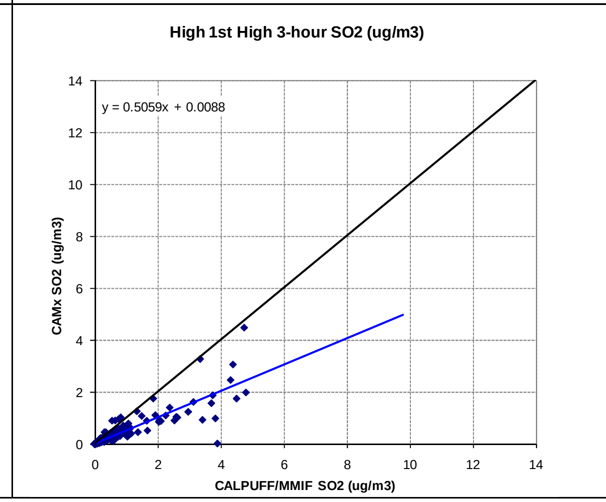








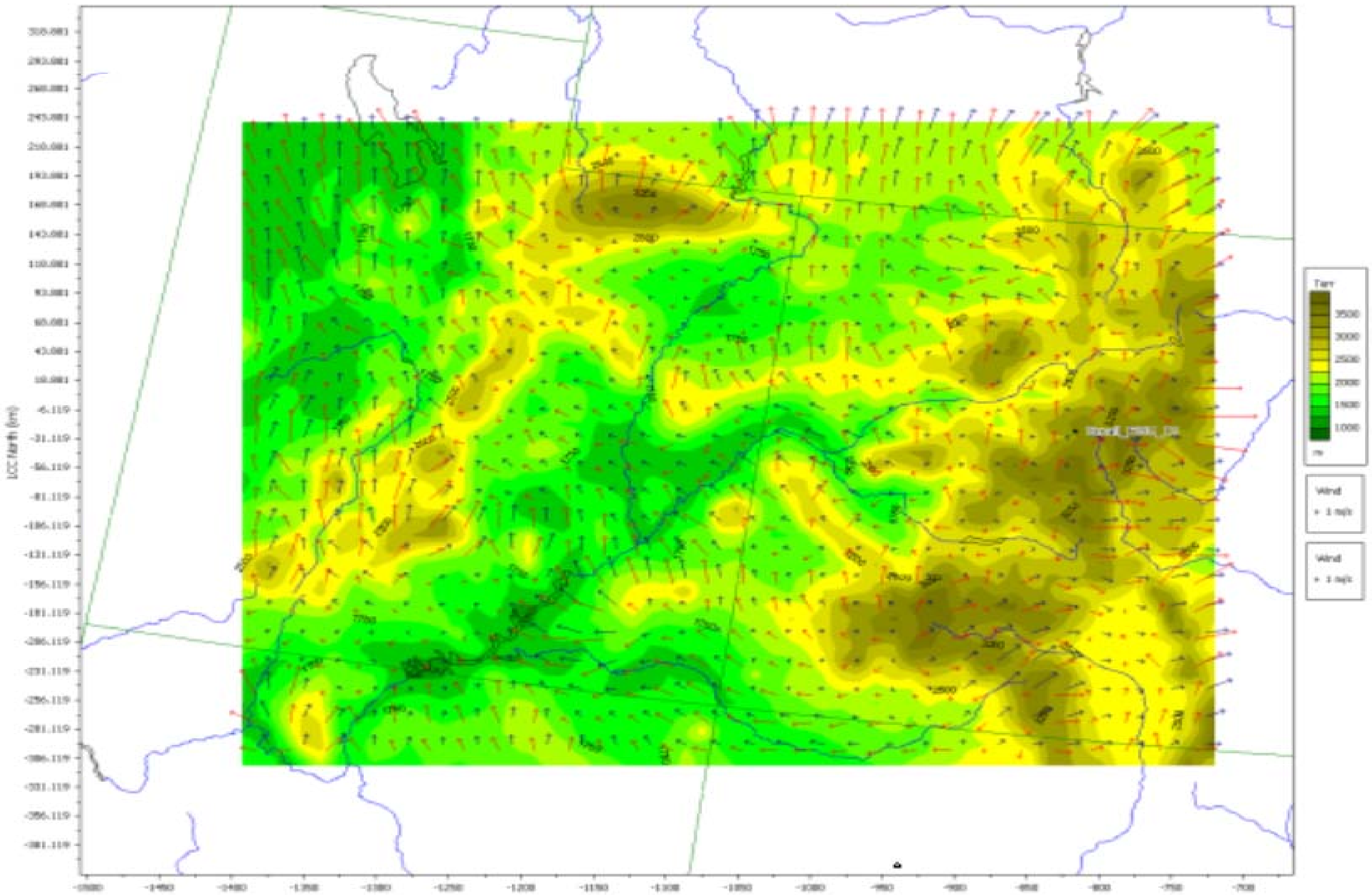




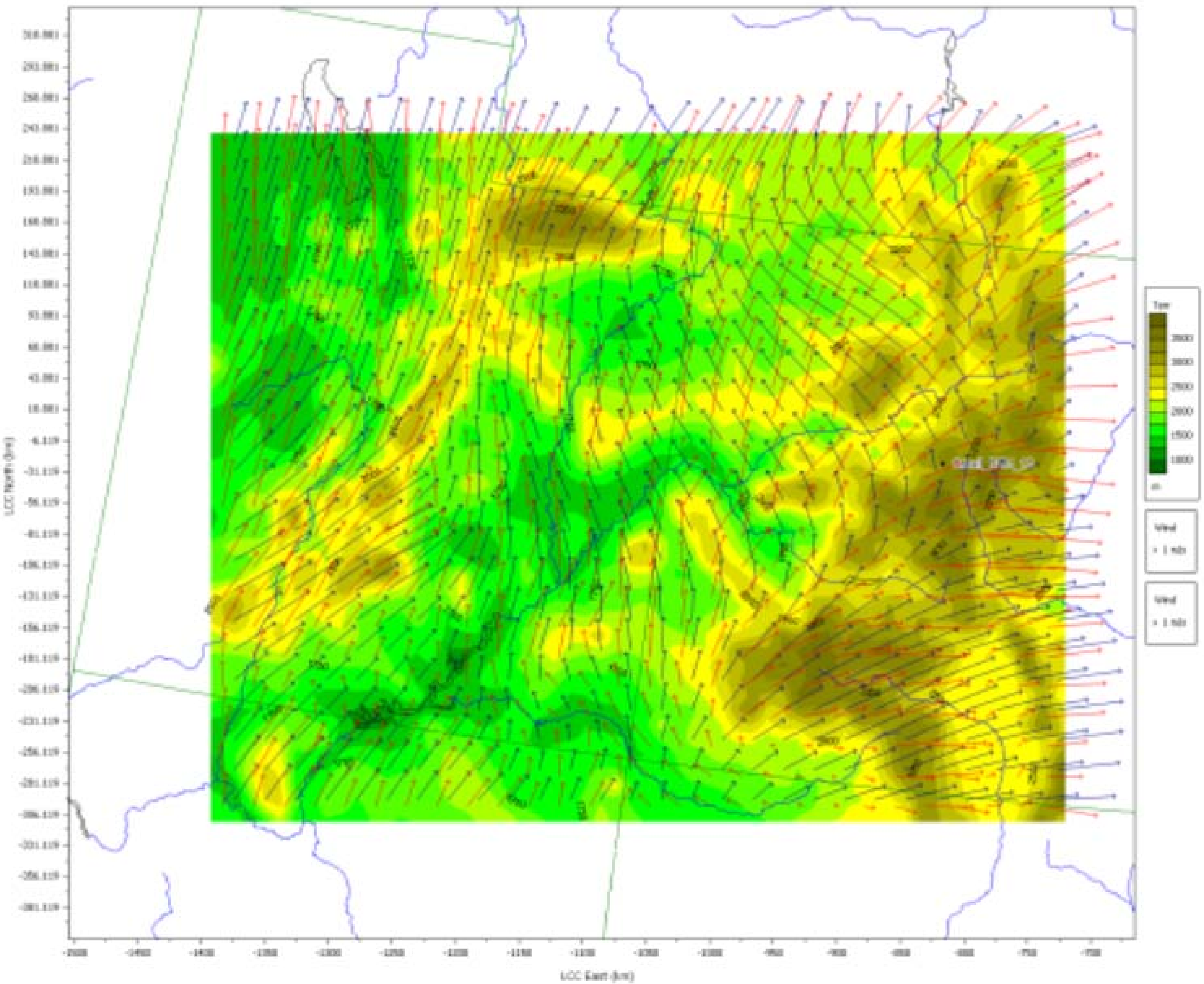
2006 12 km CALPUFF High "Outlier"

- Maximum annual NO2 and SO2 by CALPUFF/CALMET occurs for smallest EGU12 (13 TPY NOX and 1 TPY SO2)
- EGU12 located within Holy Cross Wilderness (Class II area) so likely nearly co-located with receptors
- Maximum CALMET, MMIF and CAMx annual NO2 concentrations:
  - 3.1; 0.6; and 0.02 $\mu g/m^3$
- We understand why CALMET much higher than CAMx
  - CAMx configured for LRT application with 12 km grid
- Why MMIF and CALMET so different?

CALMET (blue) vs. MM5 (red) Surface Wind Fields: 2006 12km UT-CO



CALMET (blue) vs. MM5 (red) 480 m Wind Fields: 2006 12km UT-CO

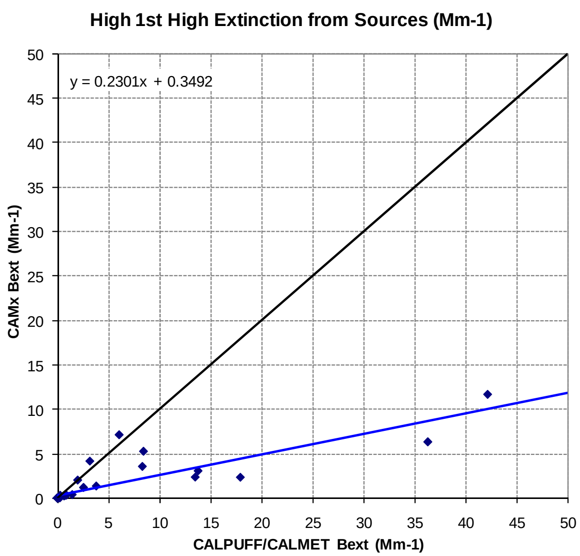


EGU12 Holy Cross Wilderness Outlier

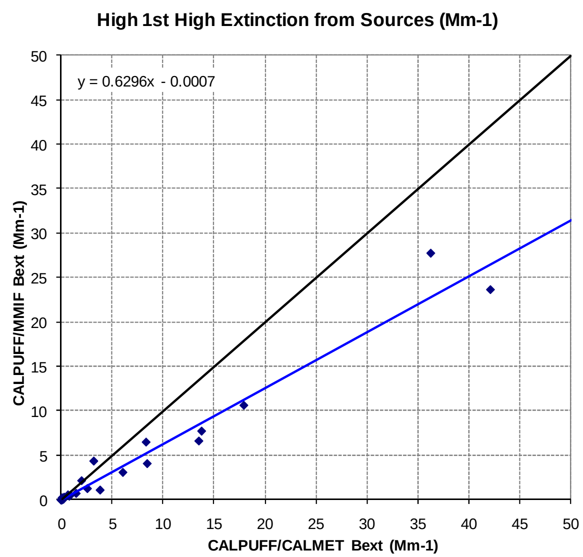
- CALMET modifying and slowing MM5 winds
- Occurs at the surface and aloft
- Unclear whether diagnostic effects or observation Objective Analysis (OA) procedure is doing this
- Occurs throughout the year
- Results in very high concentrations in CALPUFF/CALMET
- Better agreement with CAMx and CALPUFF/CALMET at other sites

2005 (top) and 2006 (bottom) Visibility

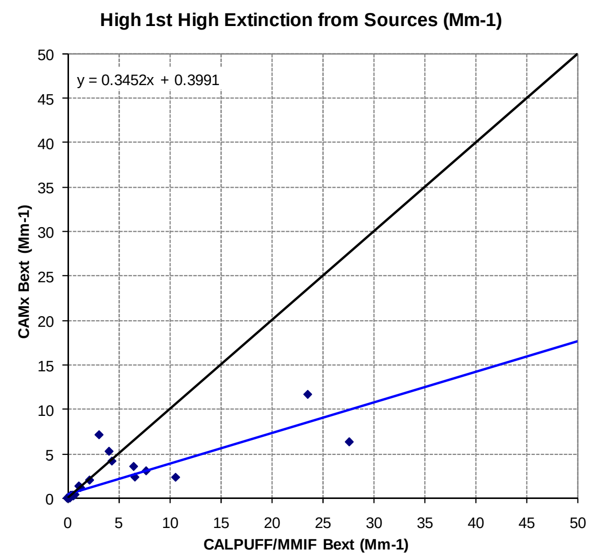
CALPUFF/CALMET vs. CAMx



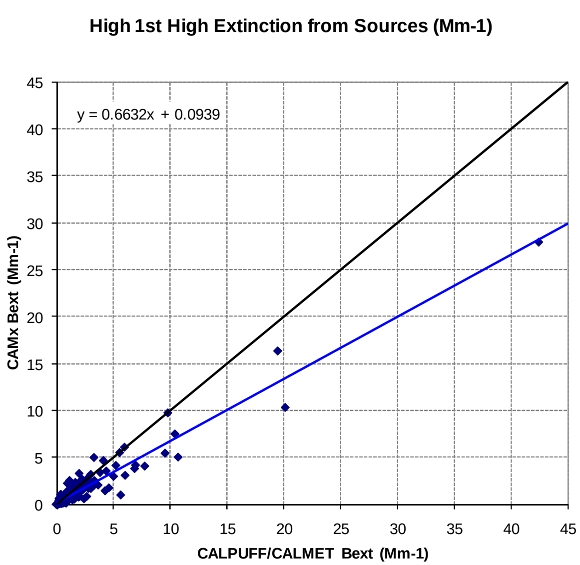
CALPUFF/CALMET vs. CALPUFF/MMIF



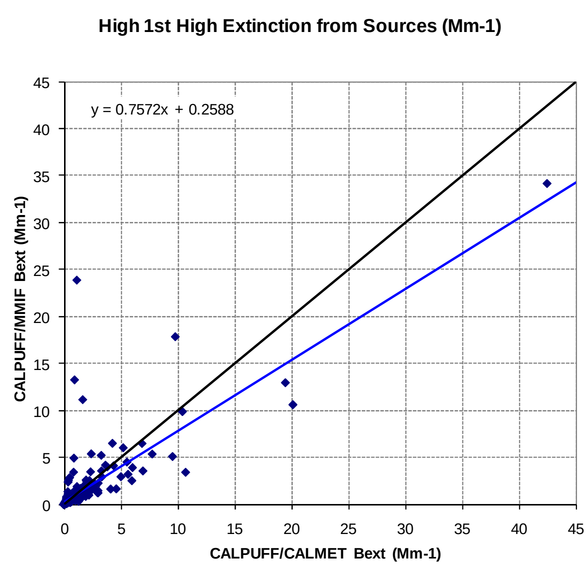
CALPUFF/MMIF vs. CAMx



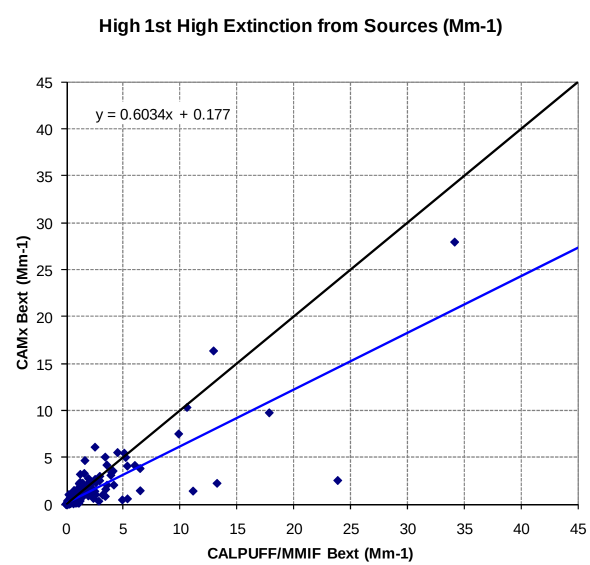
CALPUFF/CALMET vs. CAMx



CALPUFF/CALMET vs. CALPUFF/MMIF

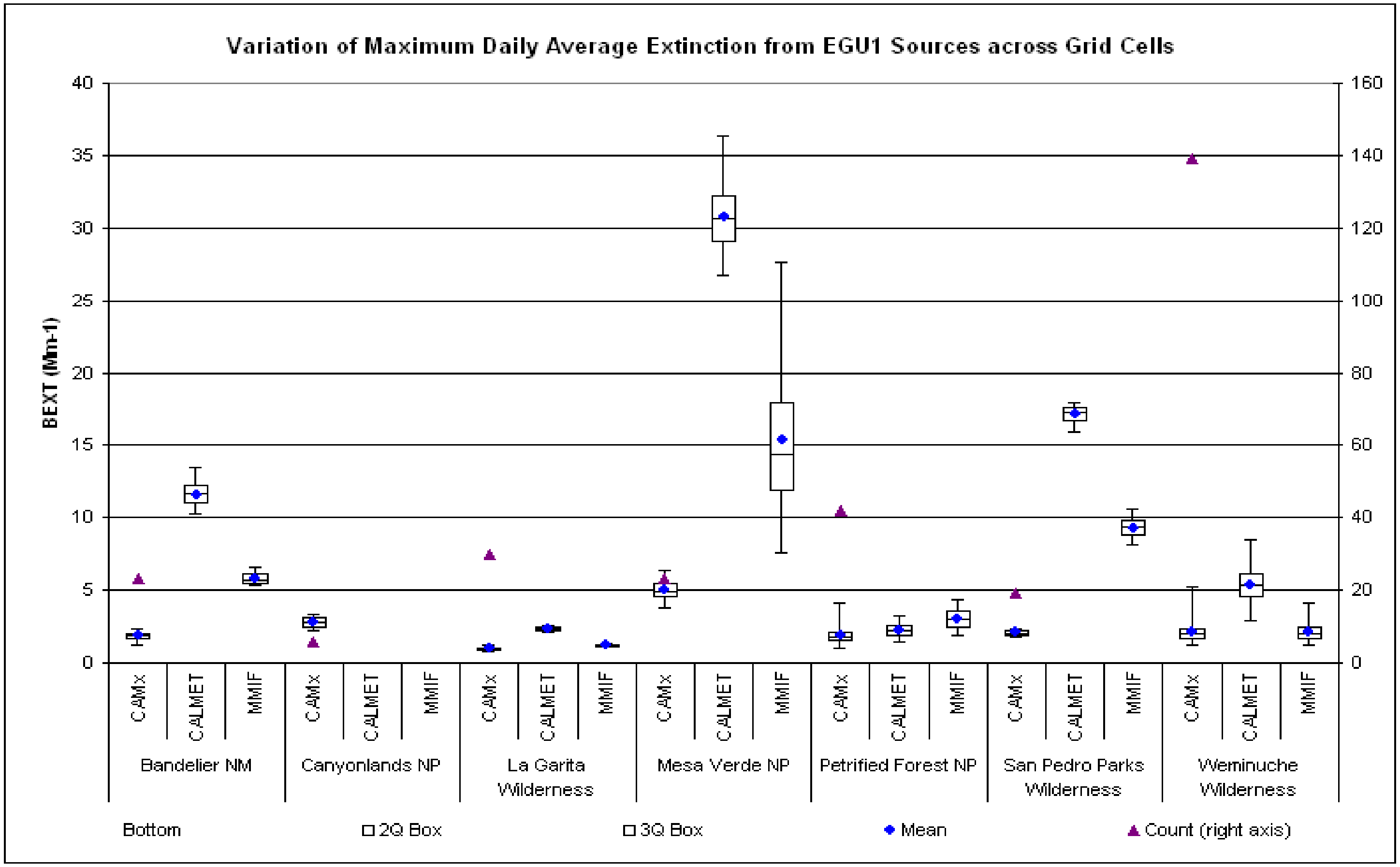


CALPUFF/MMIF vs. CAMx

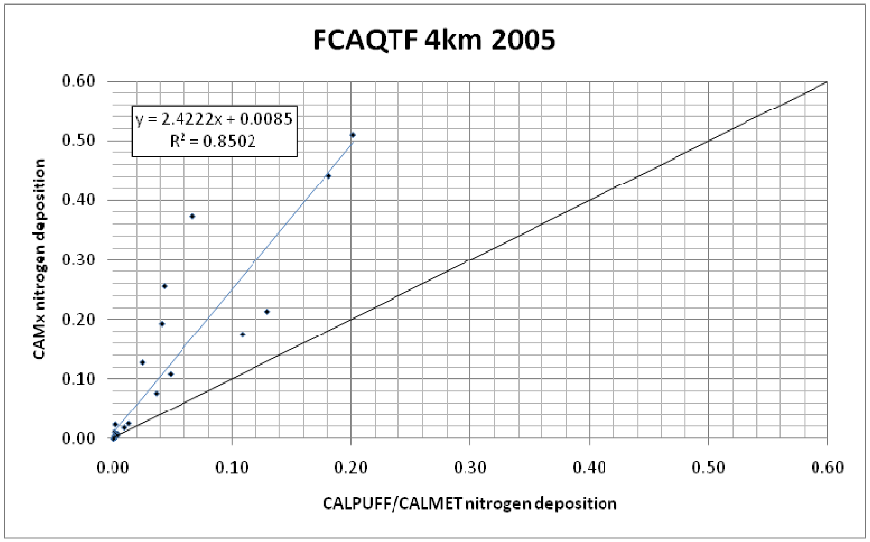


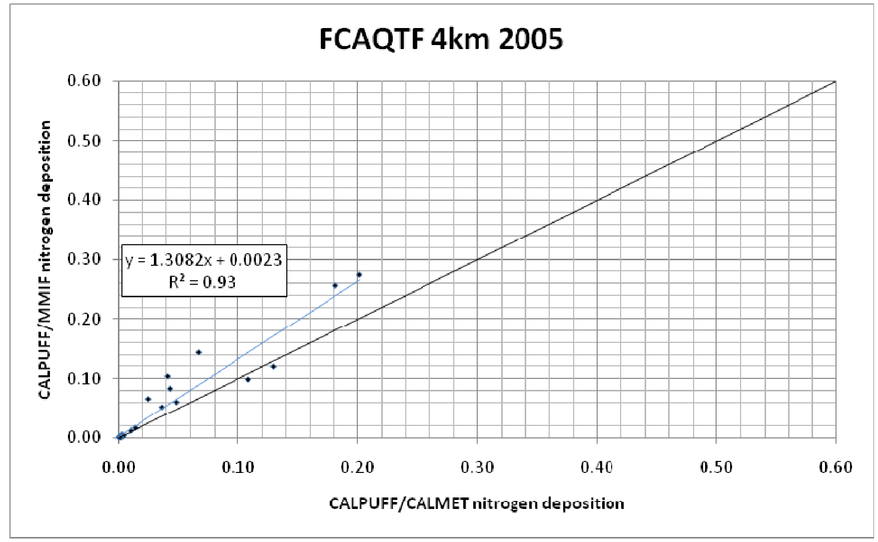
2005 4 km Maximum Visibility

- Spatial variability across receptors (CALPUFF) and grid cells that intercept Class I area
  - Except for close source-receptors, variability similar

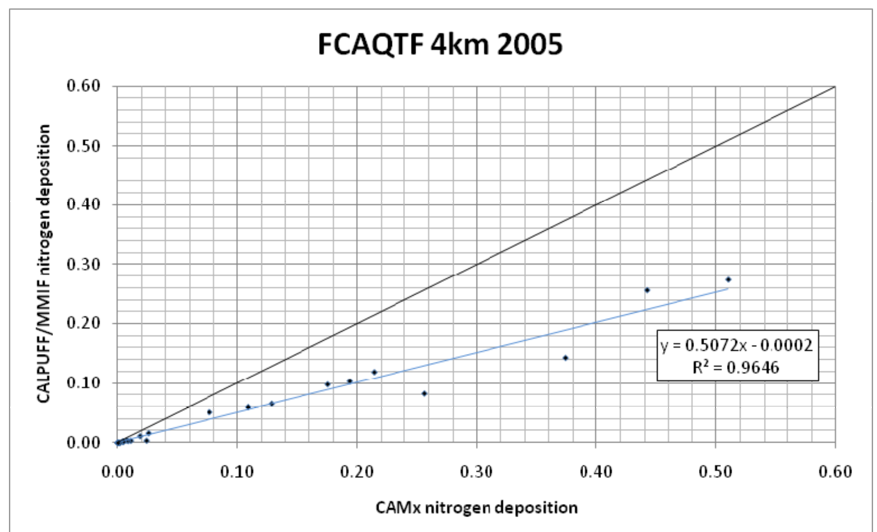


Nitrogen Deposition (kg-N/ha/yr)

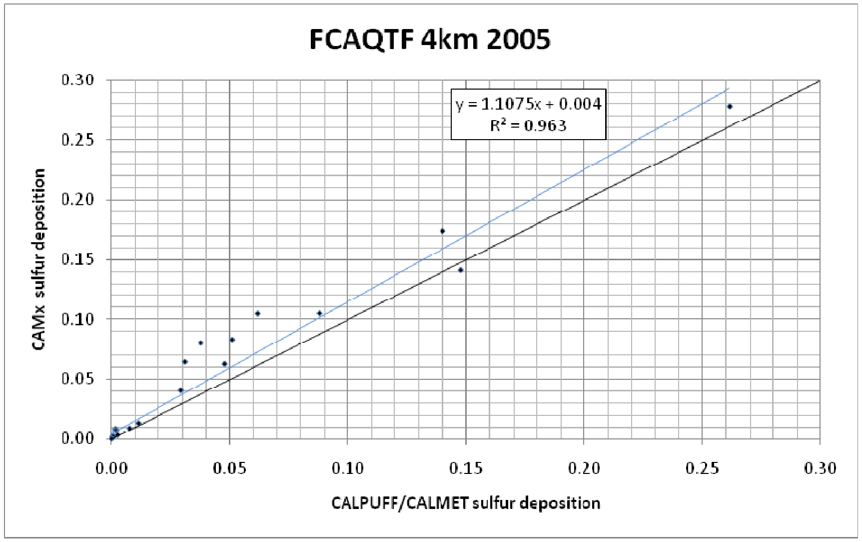


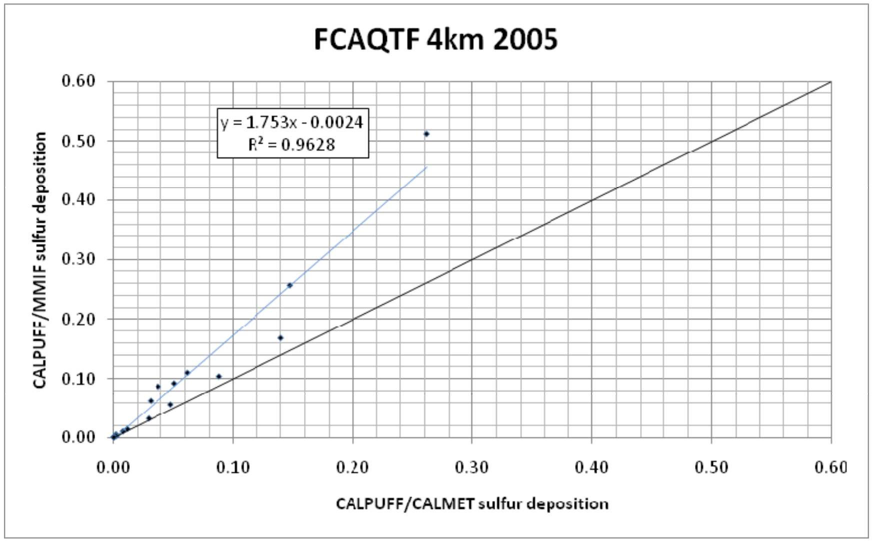


- CAMx N deposition much greater (factor of ~2) than CALPUFF
- CALPUFF/MMIF N deposition slightly greater than CALPUFF/CALMET

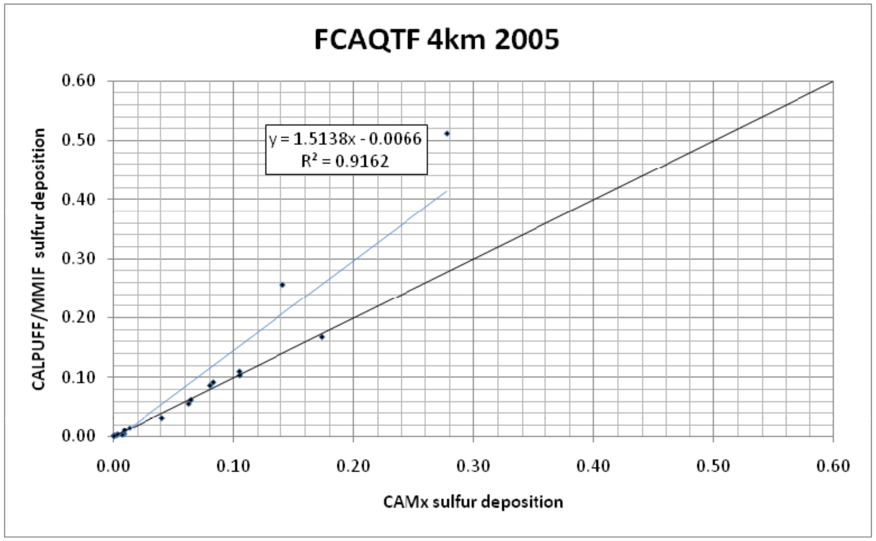


Sulfur Deposition (kg-S/ha/yr)



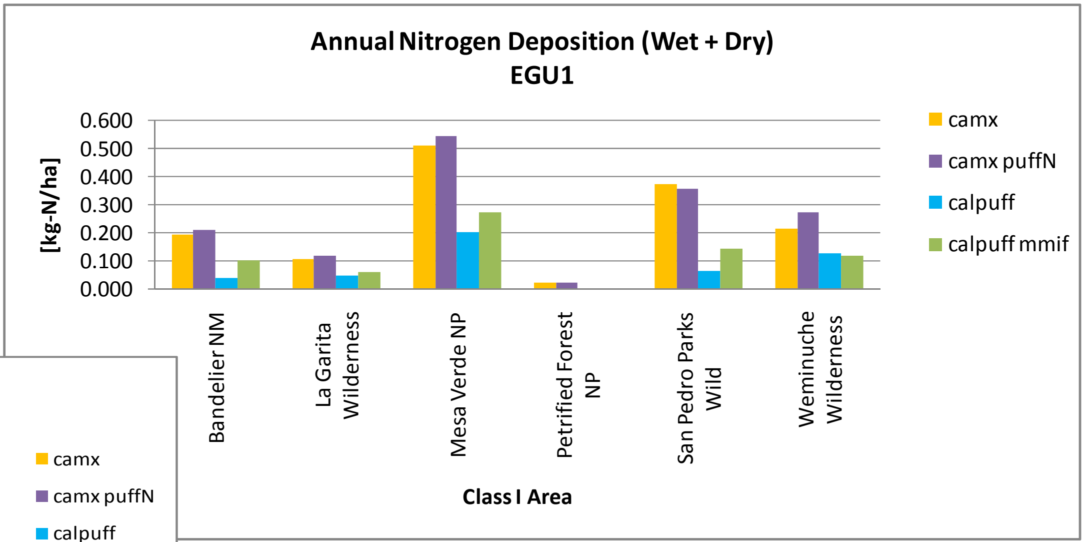


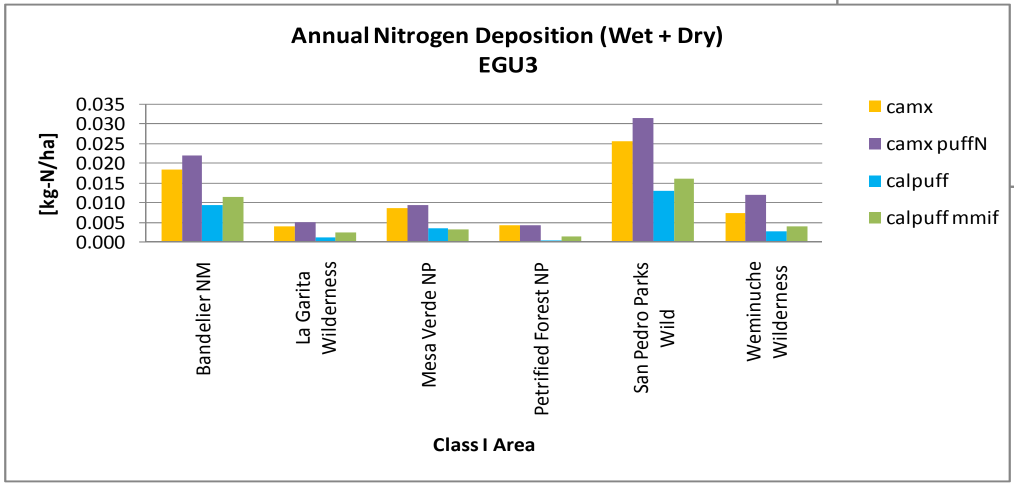
- Sulfur deposition comparable
  - CAMx > CALPUFF/CALMET
  - CPUFF/MMIF > CALPUFF/CALMET
  - Except for one point: CAMx=CALPUFF/MMIF
- (similar results for 2006)



Why CAMx Estimating Higher N Deposition than CALPUFF?

- Different species mappings with CAMx more N species and only including NH4 from test source and CALPUFF including NH4 assuming SO4/NO3 neutralized
- Performed CAMx species mapping using CALPUFF rules
  - Wrong direction for large sources
  - Not enough small sources





Why CAMx estimating higher N Deposition than CALPUFF?

- CAMx carrying more N as nitric acid (HNO3)
- CALPUFF carrying more N as particle nitrate (NO3)
- CALPUFF default ammonia background 10 ppb
- CAMx simulates ammonia/ammonium
  - Typically estimates values << 1 ppb in high terrain of Rocky Mountains
    - More representative of measurements (e.g., Dinosaur National Monument)
- Revised CALPUFF runs with more realistic background ammonia

Barriers to Implementation - Computational

- The modeling platforms for the permit modeling community are largely Microsoft Windows based and are engineered for serial applications of models.
- The meteorological and photochemical modeling community is largely Unix/Linux based.
- Time necessary for annual PGM simulations compared to current model recommended for AQRV analyses.

Computational Considerations

- Adaptation of the PGM platforms to operate in a Windows based environment?
  - The permit modeling community typically does not have the same level of fluency in either the Unix/Linux operating system or Fortran based programming skills that are essential skill requisites
  - IT authorities within State and Local permitting agencies often lack the familiarity and/or resources to dedicate to systems administration and security for Unix/Linux based systems, and thus actively prevent the acquisition of such equipment or, if such hardware is acquired, prevent the presence of such equipment on the State's internal network.

Barriers to Implementation - Regulatory

- The operational construct for the permit modeling community is highly rigid
  - Based upon a series of regulations and guidelines which restrict operational flexibility in order to promote more general consistency in the application of models.
- The operational construct of the meteorological and photochemical modeling communities is vastly different
  - Based upon a more loosely binding set of EPA recommendations which typically encourage adapting both science and modeling techniques to produce the most scientifically feasible answer given the constraints of the state-of-the-science.

Regulatory Considerations

- The differences in the operational paradigms between the two communities will require both the EPA and the FLM's to develop a more rigid set of operational procedures similar to the current permit modeling paradigm in order to insure both a scientifically sound and consistent set of procedures to prevent an 'anything goes' process as would likely develop without such procedures.
- Length of meteorological record for PGM's will likely have to be expanded to be consistent with requirements of GAQM (e.g. 3 years of prognostic data).
- Development of significance thresholds for single source (cause or contribute test) required for NAAQS demonstrations.

Conclusion

- PGM's capable of assessing single source impacts for both AQRV and ozone requirements under PSD.
- Source apportionment eliminates need for multiple "zero-out" runs
- Significant barriers remain to implementation of PGM's
  - Increased computational requirements
  - Increased training requirements for permit modeling staff
  - Creation of a hybrid regulatory and guidance framework for implementation of PGM's within a regulatory permit modeling paradigm which is highly rigid and prescriptive