

# Particulate-Matter Modeling in Northern and Central California

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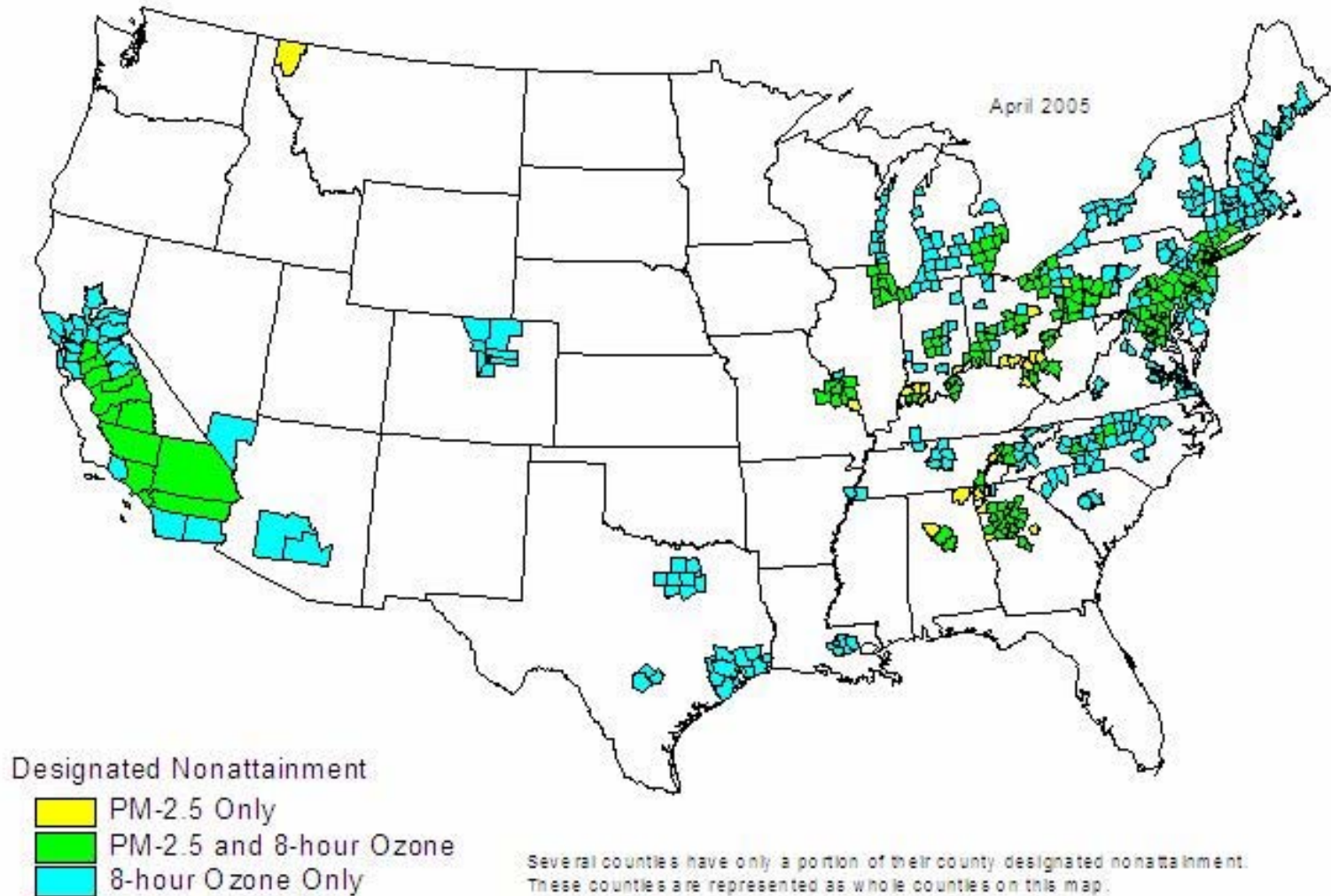
# Collaborators

- ARB:
  - Jinyou Liang\*
  - Kemal Gürer
  - Paul Allen
  - Karen Magliano
- UCD:
  - Michael Kleeman\*
  - Anthony Wexler\*
  - Max Zhang\*
  - Qi Ying\*
- CRPAQS Technical Committee
- DRI:
  - John Watson
- STI:
  - Neil Wheeler
  - Clinton McDonald
- Future:
  - Christian Seigneur - AER
  - Yang Zhang - NCSU
  - Mark Jacobson - Stanford
  - Kim Prather - UCSD
  - Steven Reynolds, Envair

# Outline

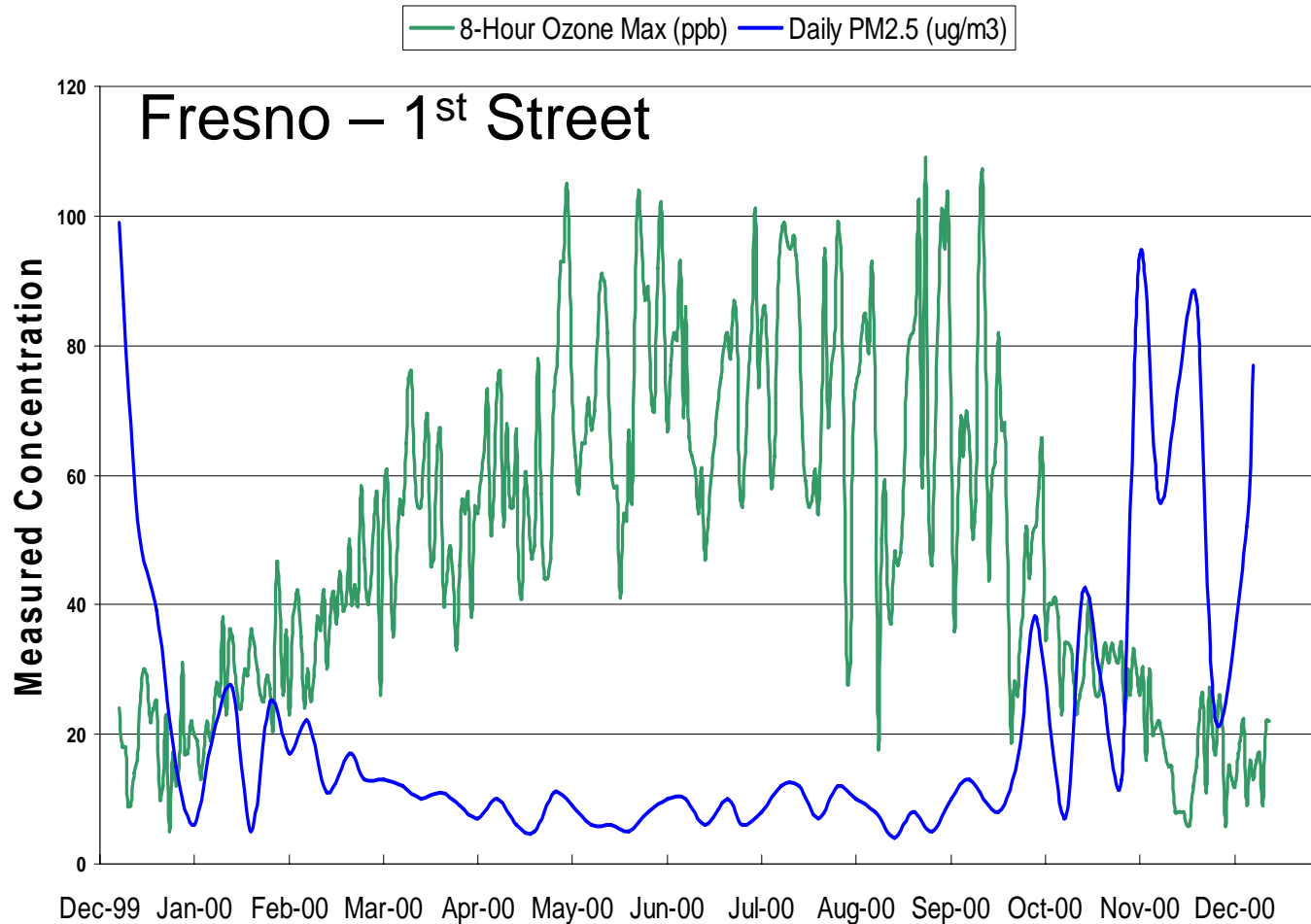
- PM<sub>2.5</sub> problem in the SJV
  - Geography
  - Seasonality
- Air Quality Modeling with CMAQ
  - Inputs
  - Improvements
  - Performance
- Future Directions

# Counties Designated Nonattainment for PM-2.5 and/or 8-hour Ozone Standard



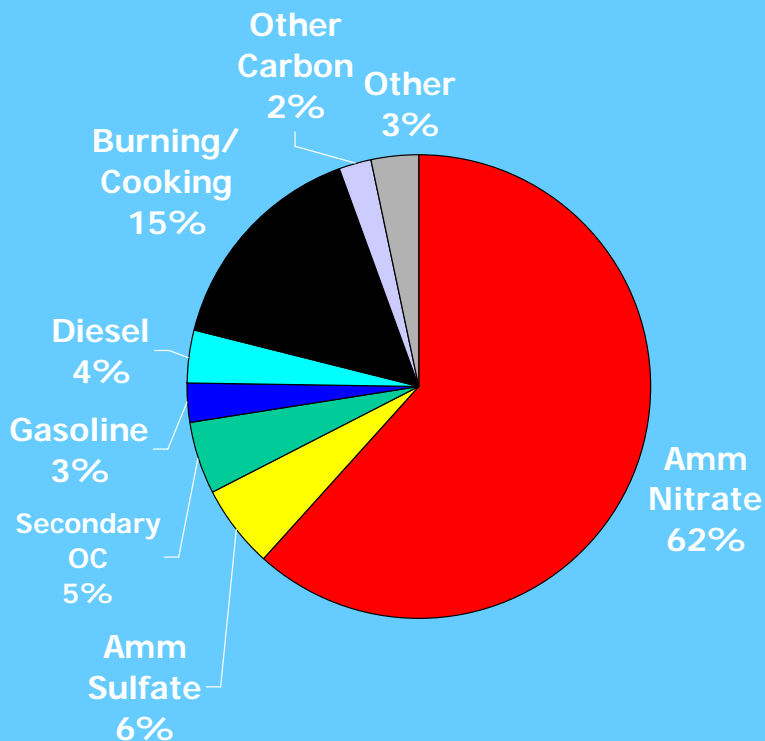


# Seasonality of O<sub>3</sub> and PM<sub>2.5</sub>

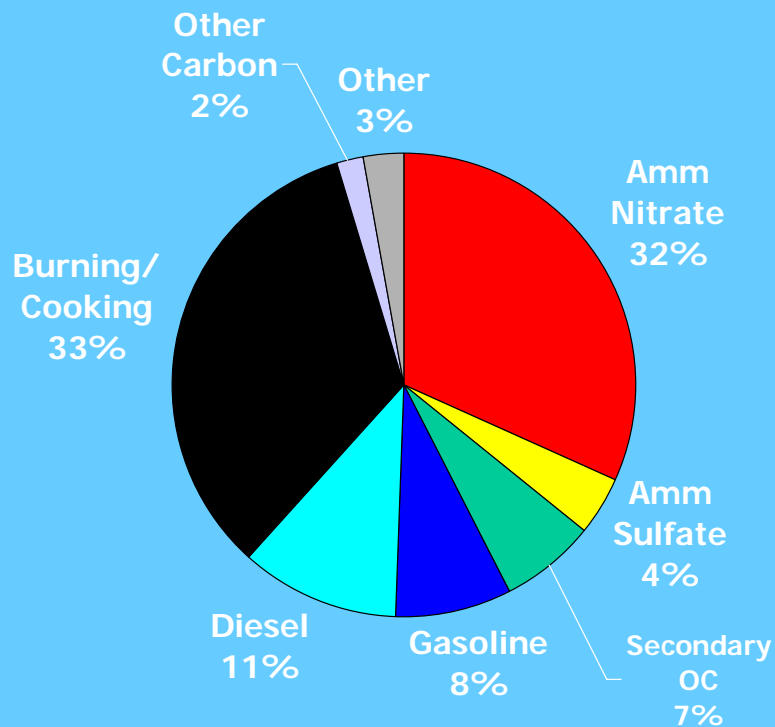


# Contributing Sources

## 24-Hour PM2.5 Spatial Variation

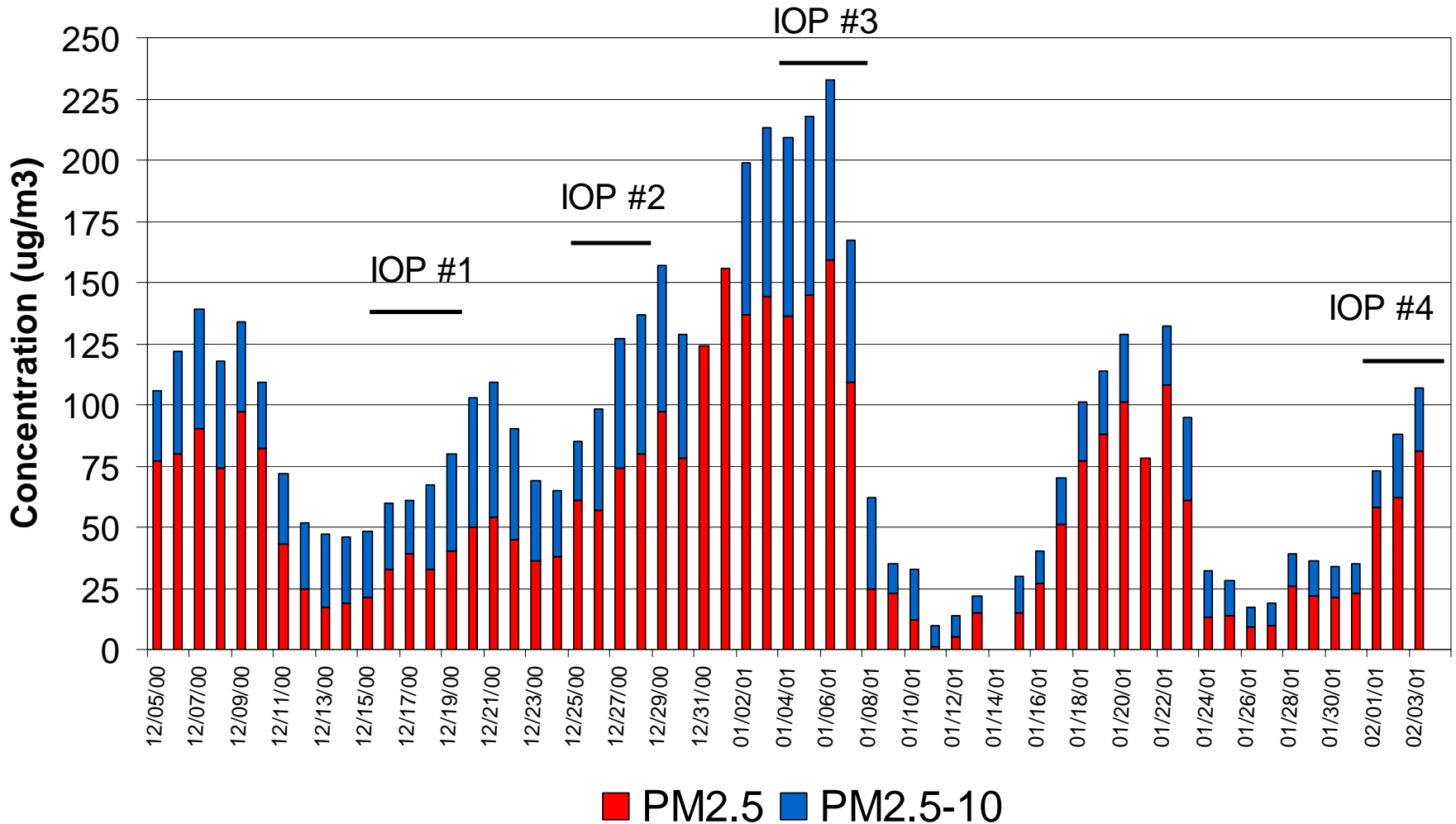


**Bakersfield**  
76 ug/m<sup>3</sup>



**Fresno**  
69 ug/m<sup>3</sup>

# Preliminary PM Concentrations at Bakersfield-California





# Modeling Approach

- Use data from California Regional PM10/PM2.5 Air Quality Study (CRPAQS)
- MM5 meteorology now but may need alternative methods
- ARB/UC Davis emissions inventory
- Several AQ modeling approaches
  - CMAQ
  - CMAQ-UCD
  - CMAQ-MADRID
  - CIT/UCD

# Mesoscale Model 5

- First serious application of MM5 to a winter episode in northern California
- No observation nudging so far
- Observation data for nudging being agreed upon by stakeholders
- Observation nudging does not necessarily improve results
- Exploration of alternative methods may be needed

# Emissions Inventory

- Less confidence in PM inventories compared to gas-phase inventories
- Lack of source profiles for PM with sufficient size resolution
- Lack of information on biogenics
- NO<sub>x</sub> emission issues in Bakersfield (now resolved)

# ARB CMAQ Modeling

- Liang *et al.* at ARB
- 4 km<sup>2</sup> horizontal grid (185x185) with 15 vertical layers up to 15 km
- Internal mixture, modal approach, SAPRC99\_ae3\_aq
- ~22-day run on 16-CPU Linux cluster in ~4 days
- ~132 GB of output per run

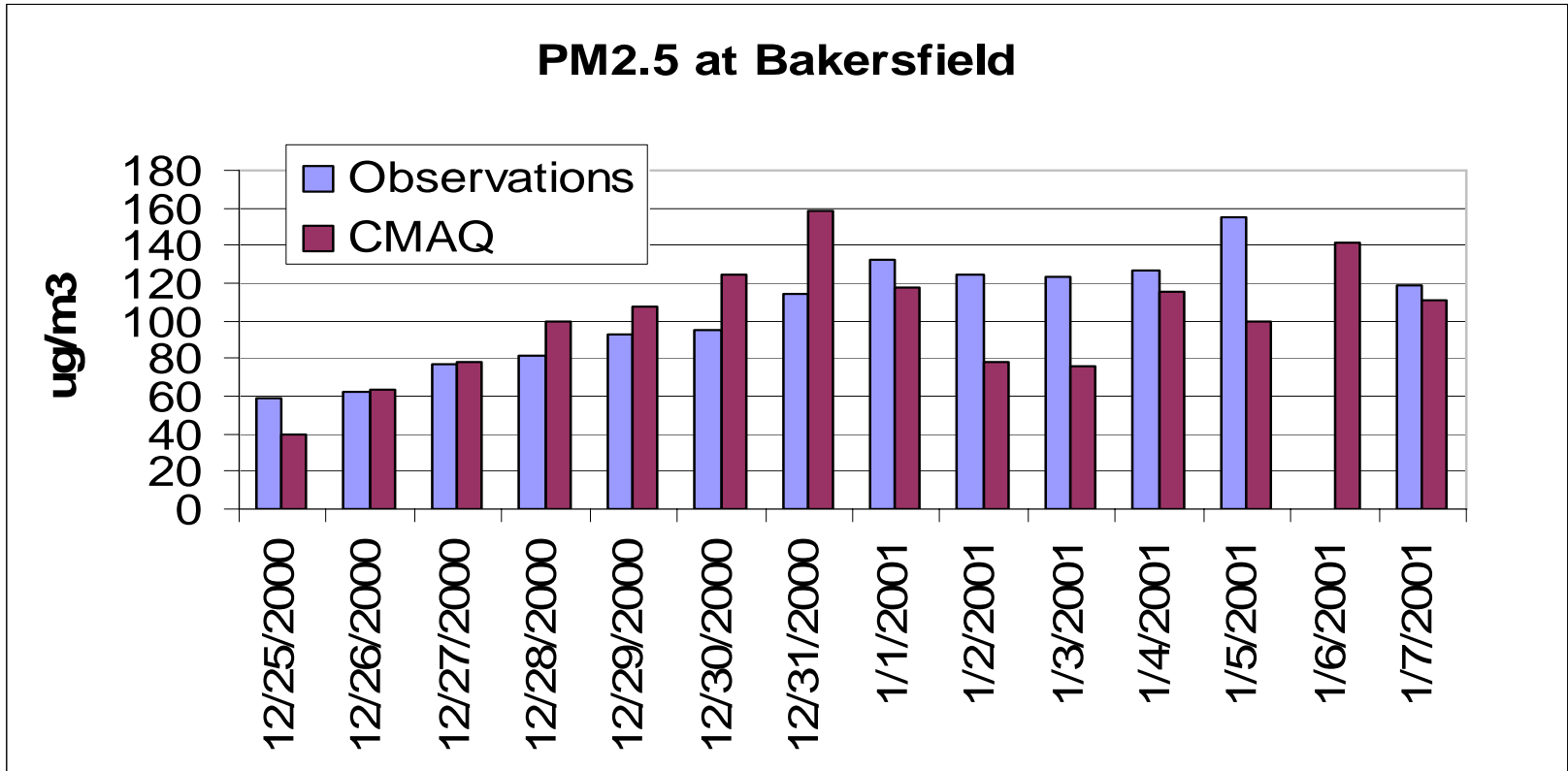
# CMAQ Modeling Issues I

- Code crash due to large  $V_d$  for wet PM
  - Added a floor value to concentration array, and put a constraint to the size distribution parameters of fine PM
- Gas SULF emissions to PM SO<sub>4</sub>
  - EPA fixed unit conversion (Prakash Bhave)
- Catalytic pathway to SO<sub>4</sub> too fast
  - Cap ionic strengths
- Allow for hourly averaged emissions
  - ARB modification

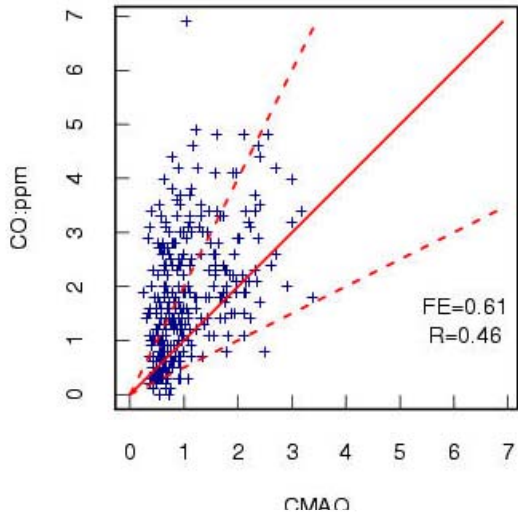
# CMAQ Modeling Issues II

- Set minimum  $k_z=0.1 \text{ m}^2/\text{s}$ 
  - ARB modification based on CO evaluation and CAMx experience in California
- DMS emission from the ocean and subsequent oxidation into sulfate
  - ARB modification for SECA
- $D_p$  and  $\sigma_g$  inputs for PM emissions
- Few other minor modifications

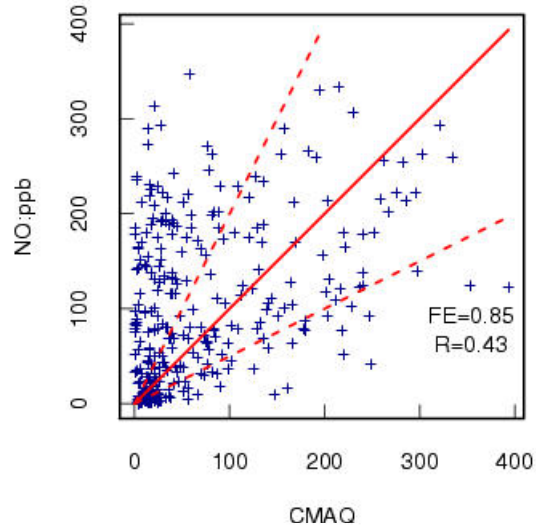
### PM2.5 at Bakersfield



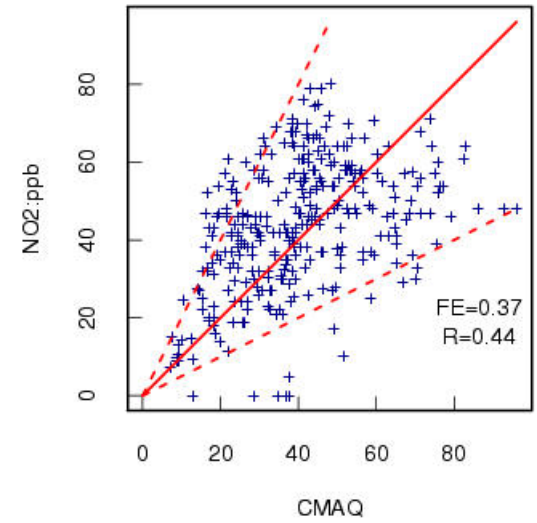
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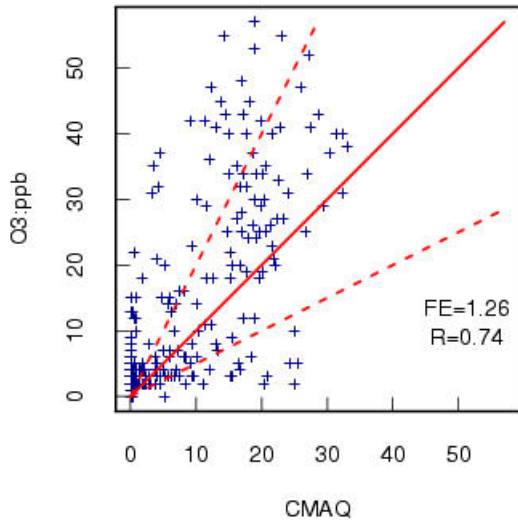
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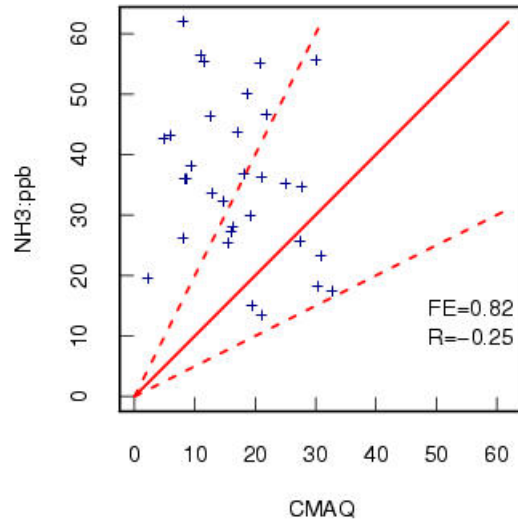
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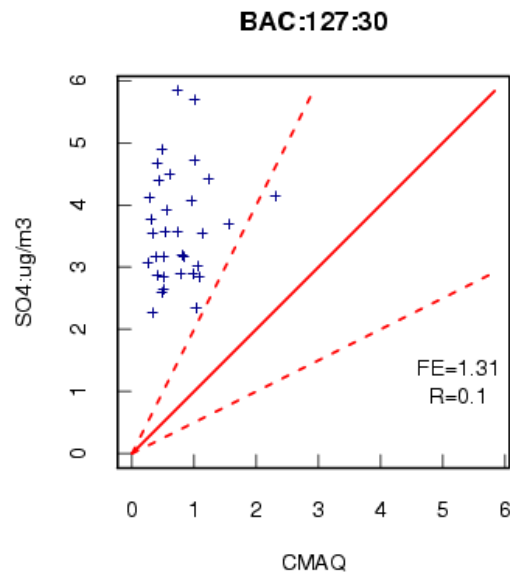
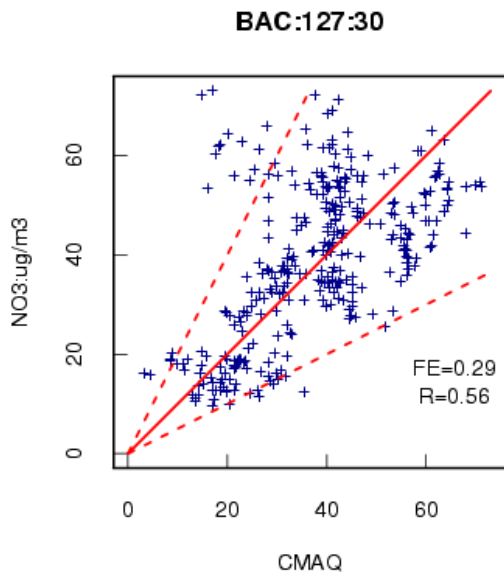
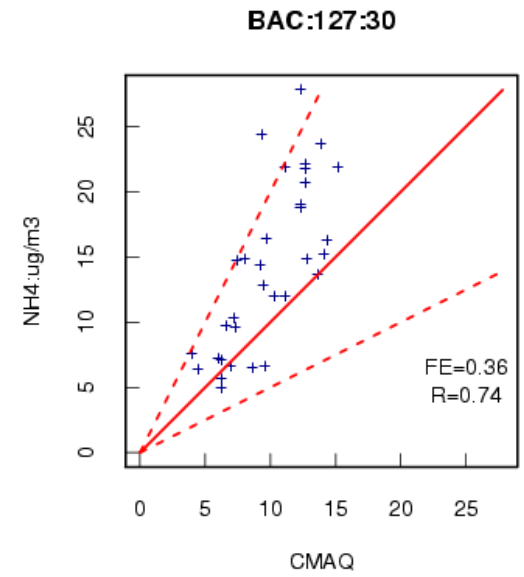
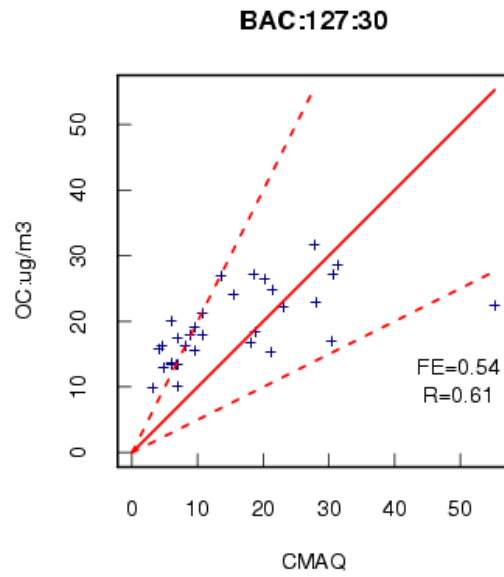
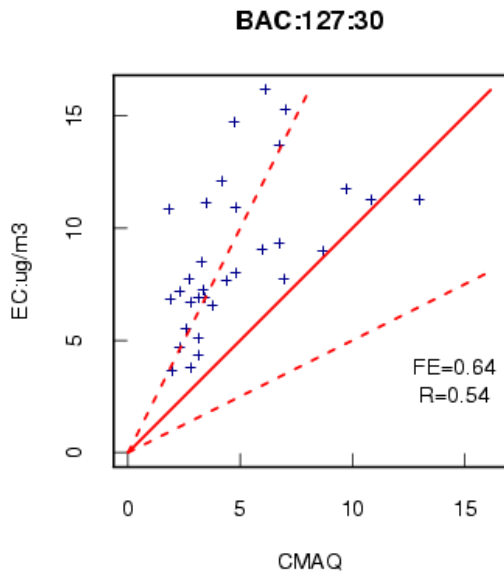
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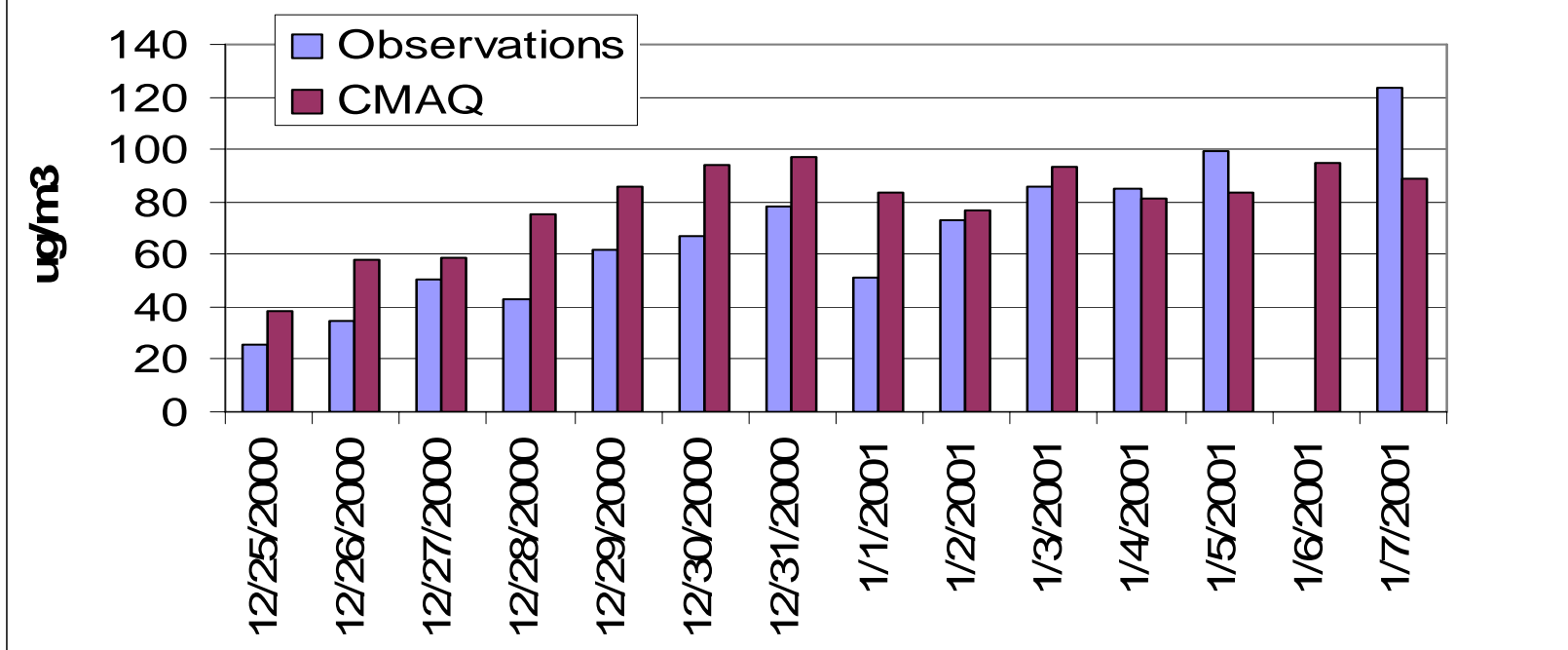
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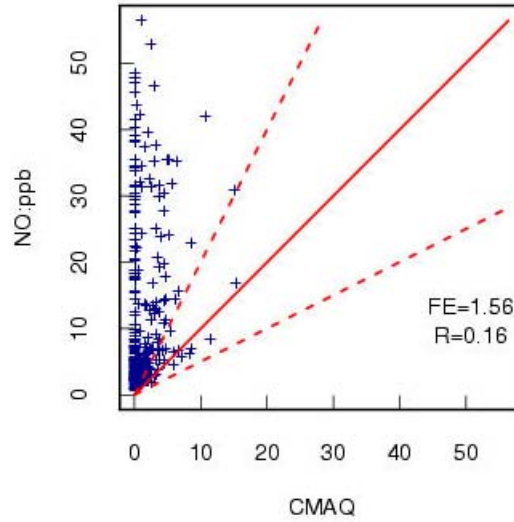




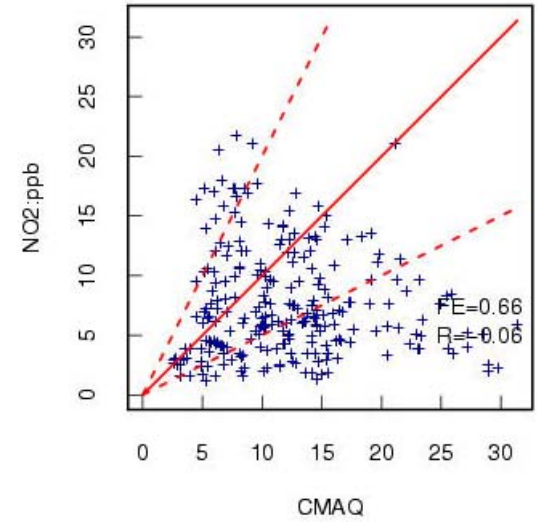
## PM2.5 at Angiola



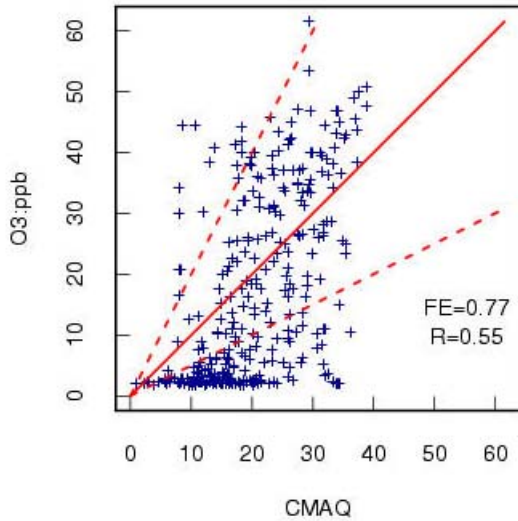
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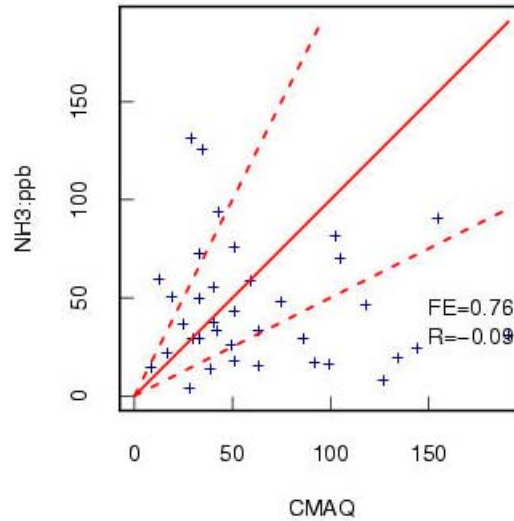
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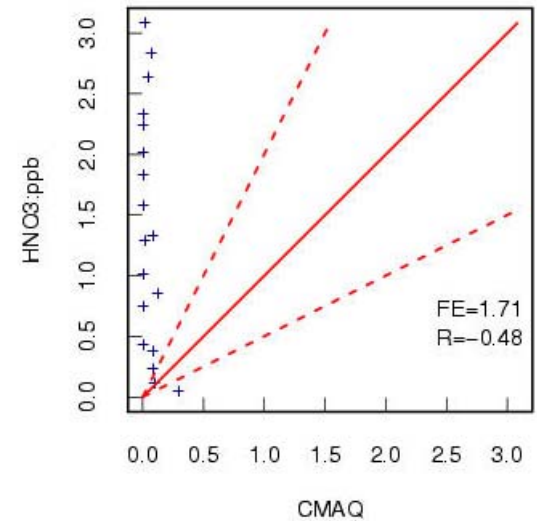
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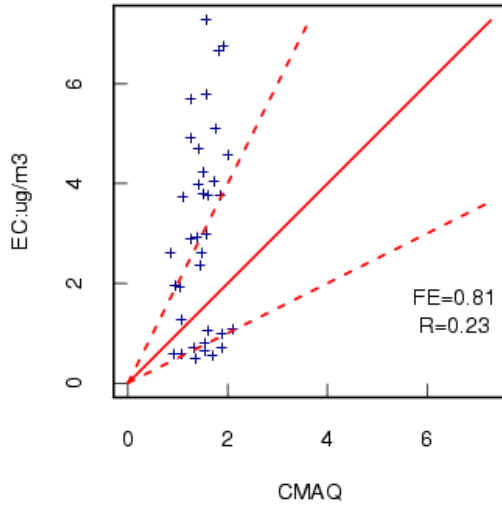
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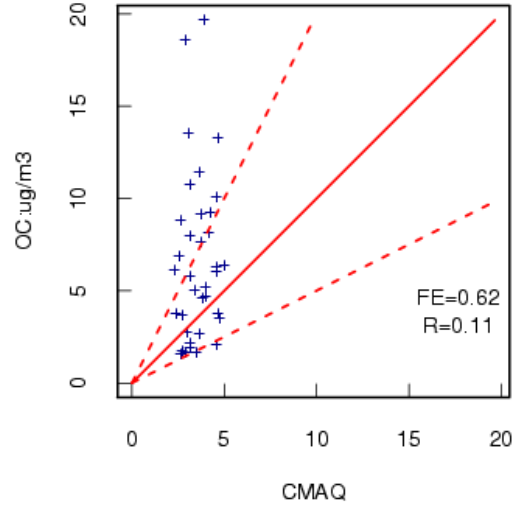
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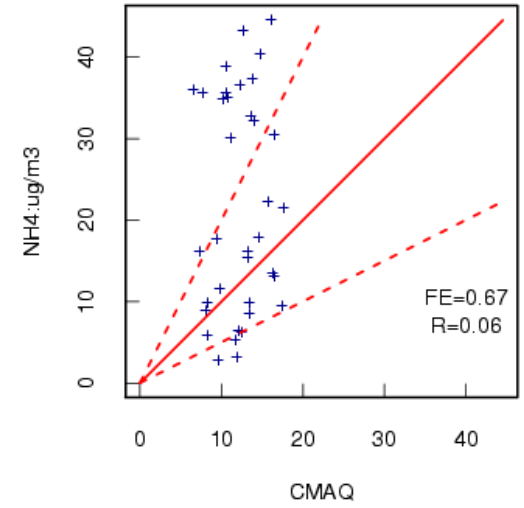
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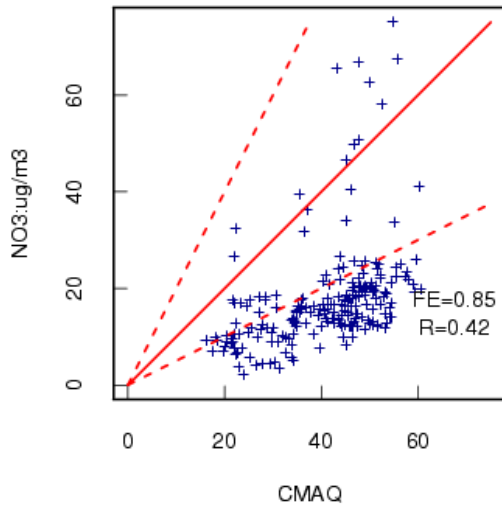
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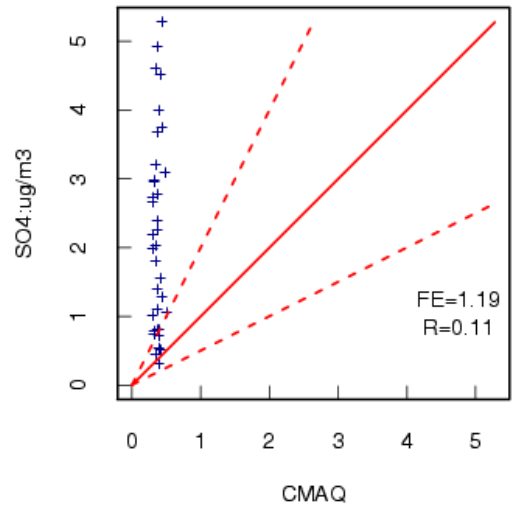
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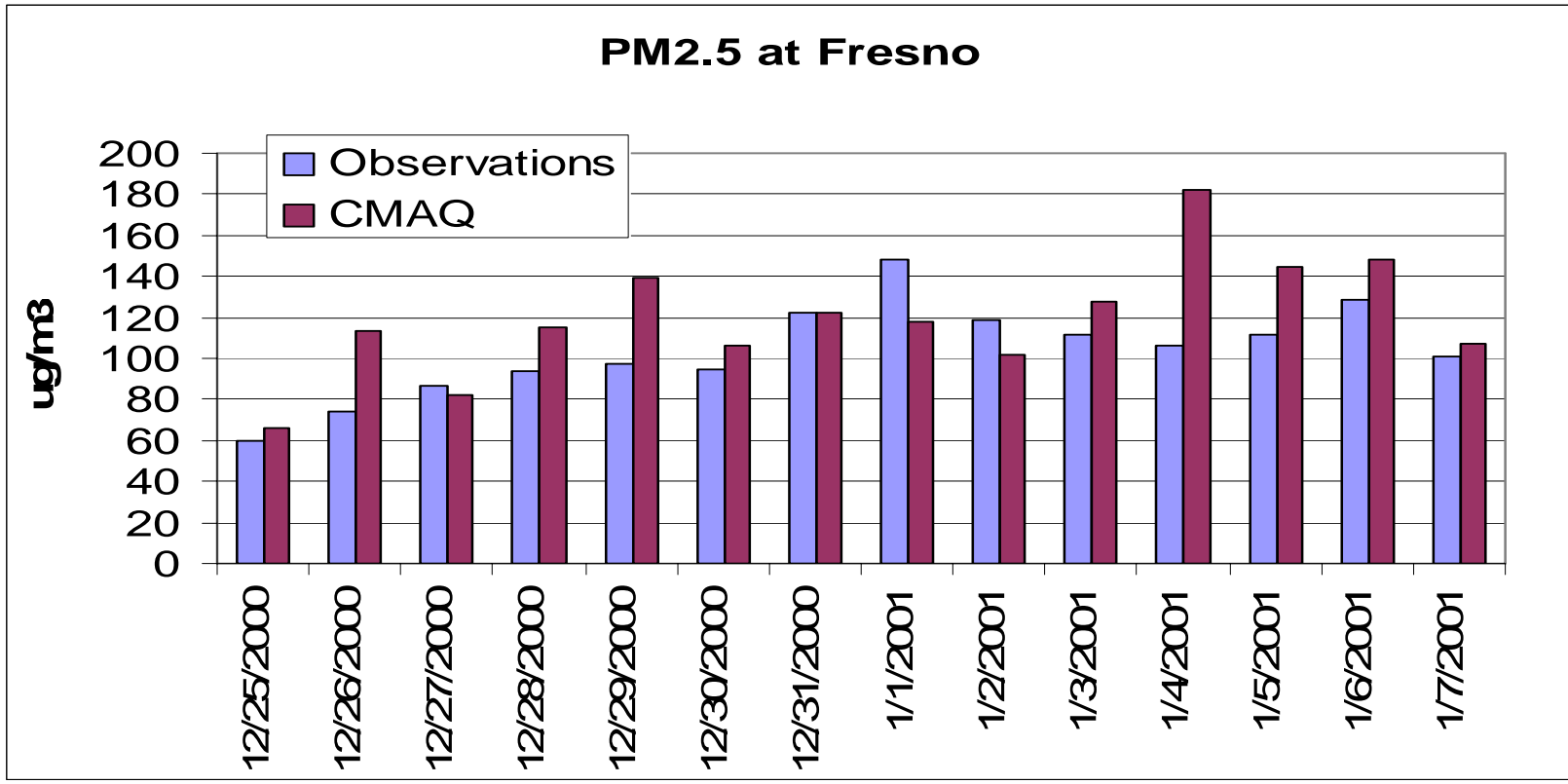
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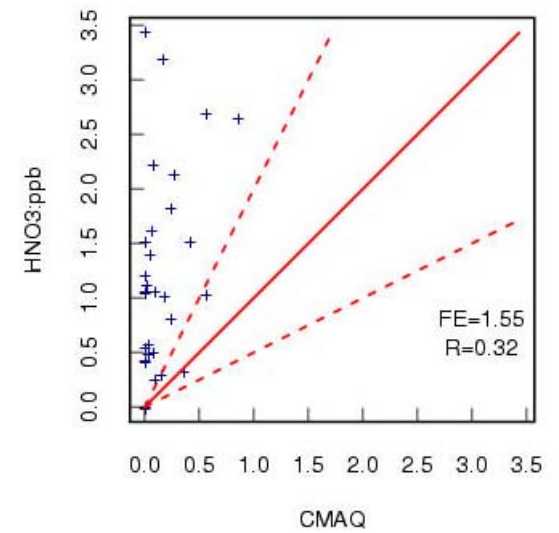
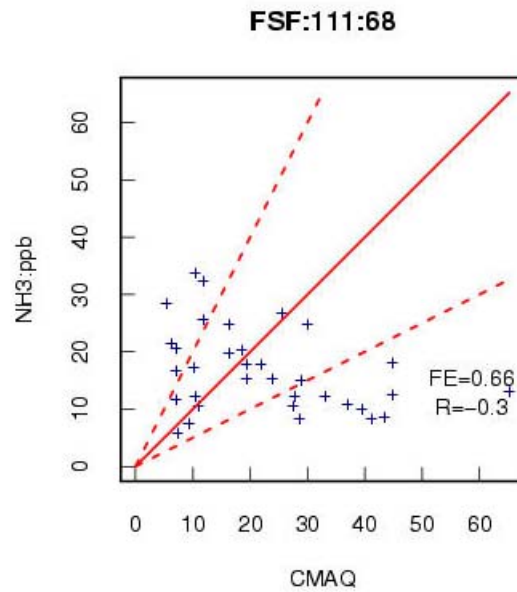
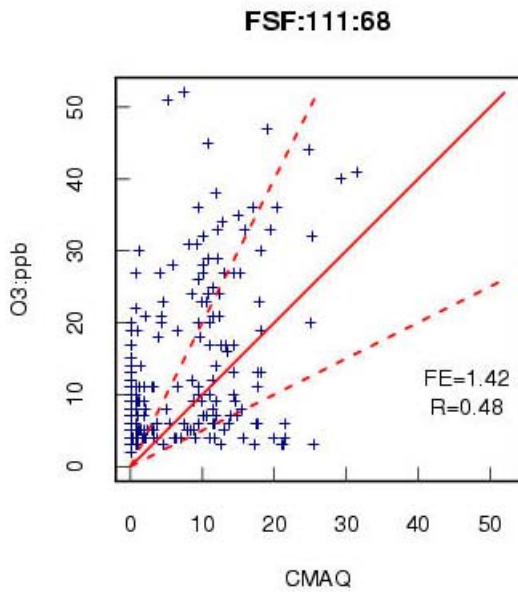
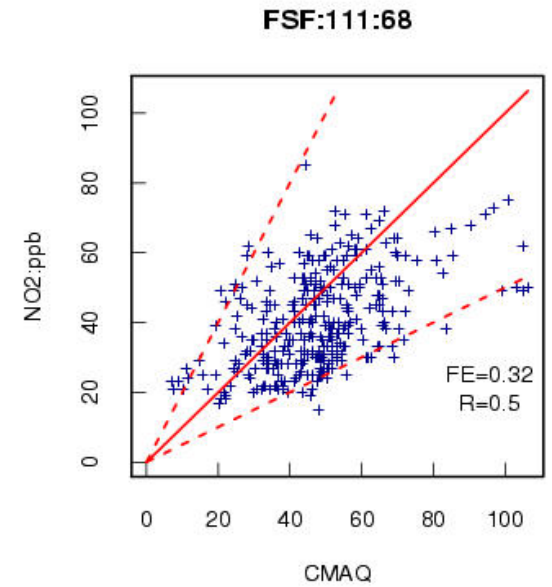
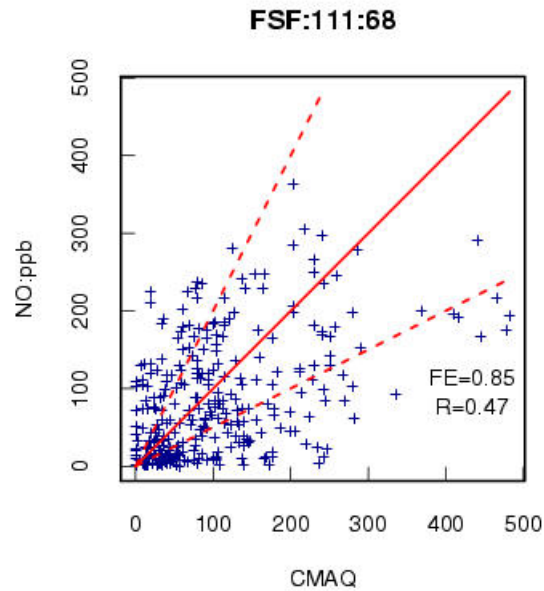
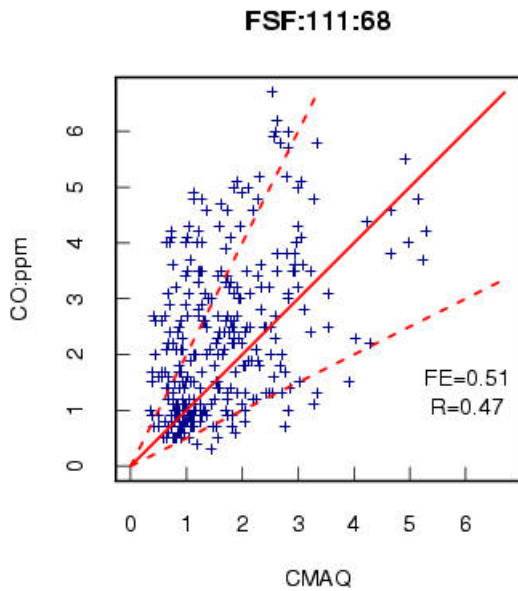


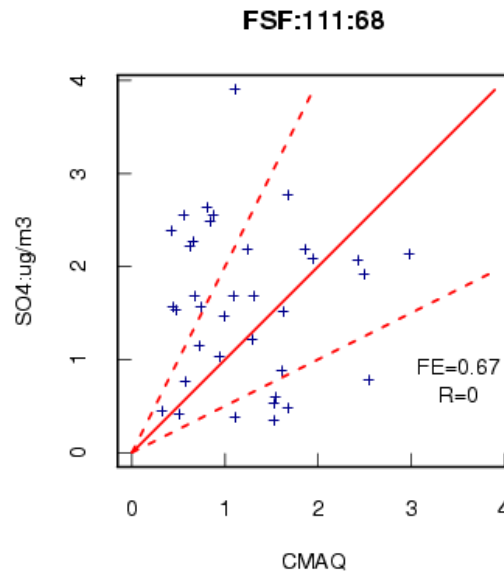
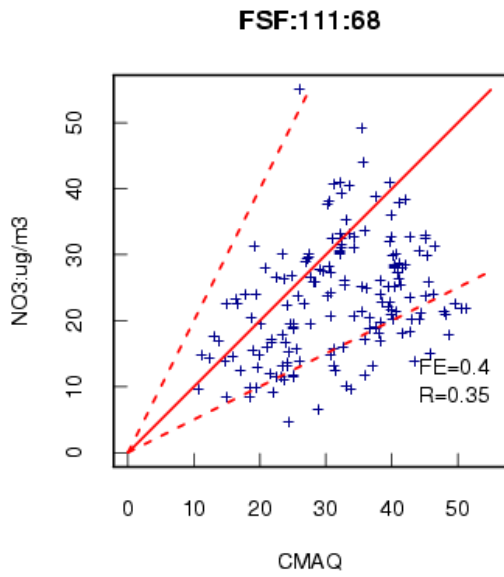
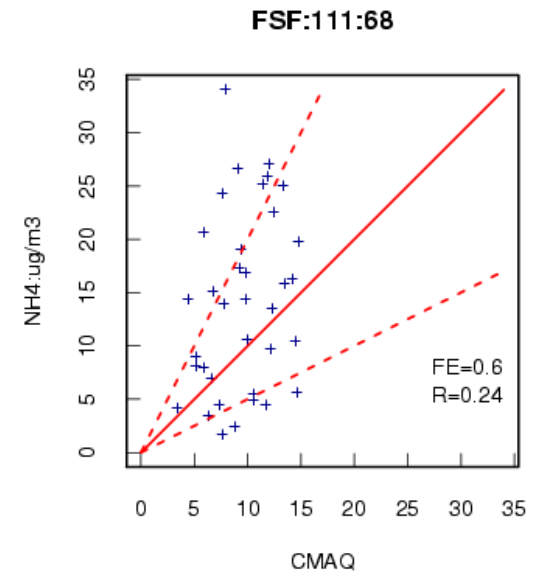
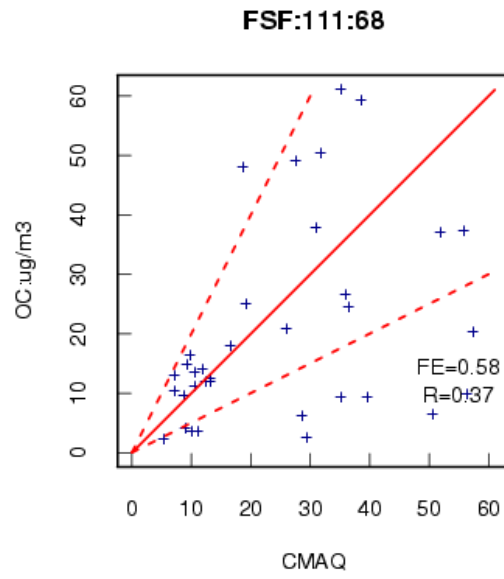
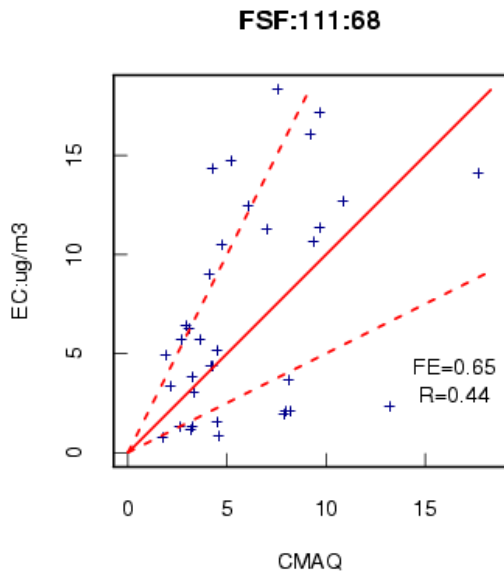
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### PM2.5 at Fresno







# CMAQ-UCD Modeling

- Zhang and Wexler at UC Davis
- 4 km<sup>2</sup> horizontal grid (185x185) with 15 vertical layers up to 15 km
- Internal mixture, sectional approach with dynamic partitioning, SAPRC99\_ae3\_aq
- ~22 day run on 16-CPU Linux cluster in 8 days
- ~180 GB of output per run



# CIT-UCD Modeling

- Ying and Kleeman at UC Davis
- 4 km<sup>2</sup> horizontal grid (<185x185) with 5 vertical layers up to 2 km
- External mixture, sectional approach with dynamic partitioning, SAPRC93
- ~22 day run on ?-CPU Linux cluster in ? days
- ~?GB output per run

# Future

- Further Q/C of measured data
- Explore additional data sources (e.g., Satellite)
- Improvements to meteorology fields
- Improvements to emissions inventories
- Application of CMAQ-MADRID
- Conduct annual modeling using CMAQ
- Support PM<sub>2.5</sub> and Regional Haze SIPs in 2008 (with a possible regional collaboration)
- Study effects of global climate change