Status of PM Air Quality Modeling

Christian Seigneur

AER
San Ramon, CA

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Atmospheric and Environmental Research, Inc.

Conclusions from the 2003 NARSTO Assessment

NARSTO: Performance evaluation of PM air quality models has been limited to date, especially outside of southern California and the summer season, and needs to continue and to expand

Today:

- We now have results for various areas in the U.S. and in other countries (e.g., Canada, Europe)
- The performance evaluations, however, are mostly operational

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Conclusions from the 2003 NARSTO Assessment

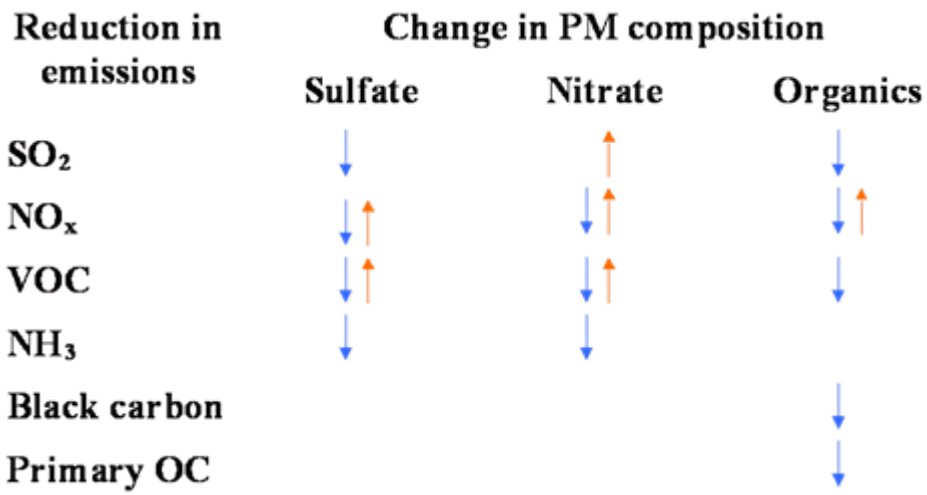
NARSTO: The skill of PM air quality models varies among PM components and, in some cases, it is limited by uncertainties in the understanding of some PM processes (e.g., SOA formation)

Today:

- Our understanding has progressed but there are still very large gaps in our understanding of organic PM
- Model inputs (emissions, meteorology, boundary conditions) also limit model accuracy

Conclusions from the 2003 NARSTO Assessment

NARSTO: Current PM air quality models are better at predicting the direction of changes than the absolute magnitude of changes



Today:

- Still true but one should not take for granted that air quality models can always predict the direction of changes because those can be intricate

Conclusions from the 2003 NARSTO Assessment

NARSTO: PM air quality models are still in the early stages of development and at this time they should be used as part of collective scientific analyses, that include other air quality models, receptor models and observation-based models

Today:

- Although some progress has been made over the past few years (e.g., nitrate), there are still many areas that need further development (e.g., organics)
- Mature PM air quality models will still be limited by the accuracy of their inputs (emissions and meteorology) and corroborative modeling techniques should continue to be used

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Conclusions from the 2003 NARSTO Assessment

NARSTO: PM air quality models have the potential to provide very useful guidance to policy makers, but model development needs to continue

Today:

- PM air quality models provide quantitative answers
- However, those answers are still highly uncertain
- Improvements in models inputs (emissions and meteorology) need to happen in parallel with PM model development

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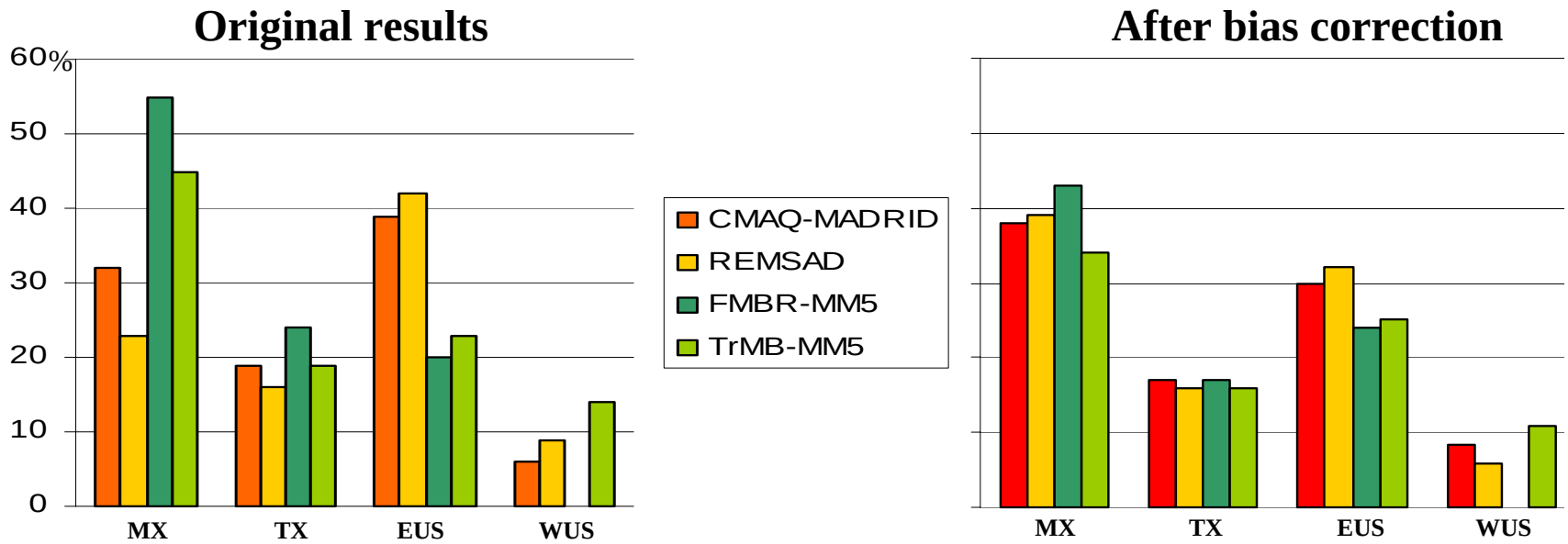
Use of Collective Scientific Analysis Example of BRAVO

- Several modeling techniques were used for source attribution
  - PM air quality models
    - CMAQ-MADRID (AER & EPRI)
    - REMSAD (CIRA/NPS & AER)
  - Receptor trajectory models
    - Forward mass balance regression (CIRA/NPS)
    - Trajectory mass balance (CIRA/NPS)

- The modeling results were then refined by correcting for their biases (CIRA/NPS)

Use of Collective Scientific Analysis Example of BRAVO



The use of different modeling tools provides a measure of the uncertainties in source attribution

The agreement among the modeling tools improved after applying bias correction

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Organic PM: Need for Model Development

- Current regulatory PM air quality models have empirical representations of organic PM formation:
  - Based on smog chamber data
  - Some VOC precursors are ignored
  - Organic PM is considered hydrophobic
  - Interactions with inorganic PM are ignored
  - Aqueous-phase processes are ignored
  - PM reactions (e.g., polymerization, oxidation) are ignored
  - Temperature dependence is based on few data

- Measurements of organic PM include measurement artifacts, EC/OC operational definition and OC/OM uncertain scaling factor

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Organic PM: Need for Model Development

- Agreement between measured and modeled organic PM concentrations is at this point to some extent fortuitous
- Model development will require a combination of laboratory data, advanced ambient data and new theoretical advances
- It will take several years before we understand the formation of organic PM with sufficient details to have any confidence in the models

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Some Other PM Issues

- Coarse PM
  - Possibility of a new NAAQS
  - Models will be very sensitive to emission inventories

- Ultrafine PM
  - Number concentration may be important; models do not currently simulate PM number concentrations well
  - Rapid evolution occurs between the source and the urban/regional scale; some subgrid-scale treatment will be needed