A Five-Year CMAQ $PM_{2.5}$ Model Performance for Wildfires and Prescribed Fires

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Background

- Biomass burning is an important contributor to the degradation of air quality because of its impact on ozone, particulate matter and Hazardous Air Pollutants (HAPS).
- CMAQ is a chemical transport model for simulating regional air quality
- Five years of simulations with and without wild fires and prescribed fires are analyzed.
- What can we learn about model performance for wildfires and prescribed fires by comparing these two simulations?

Simulation Details

- 2008-2012 simulations with CMAQv5.0.1/5.0.2
- Continental US domain with 12km horizontal resolution
- SMOKE version 3.1
- **2008-2012 SMARTFIREv2 emissions as estimated in 2008, 2011 NEI**
- Weather Research and Forecast Model (WRF) version 3.4
- Bi-directional exchange of NH_3
- 35 vertical layers

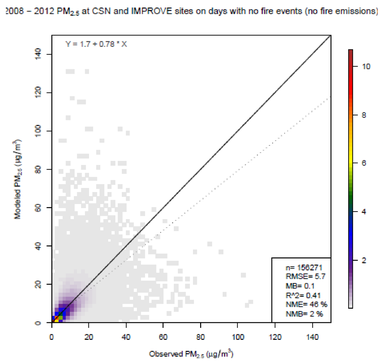
Evaluation Approach at CSN and IMPROVE sites

- Split model and observation pairs based on criteria:
  - **Fire Event = ($Model_{fires}$ – $Model_{without\ fires}$) > 5 µg/m³**
  - **No Fire Event = ($Model_{fires}$ – $Model_{without\ fires}$) < 5 µg/m³**
- Consider Model Performance for each set independently:
  - No fire event vs fire event

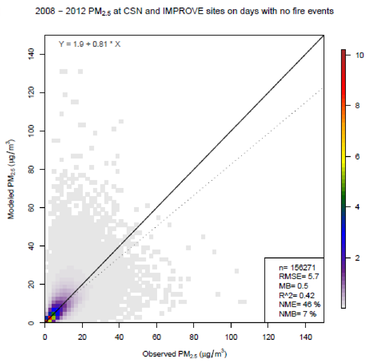
Limitations of Analysis: Only Fire Events included in the inventory are included. Errors in space/time representation of fires may have occurred but are not determined by this analysis

Model Performance for "No Fire Event" Pairs

Without Fire Emissions

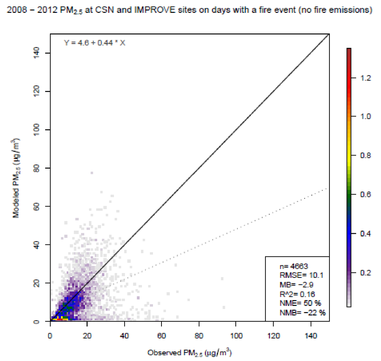


With Fire Emissions

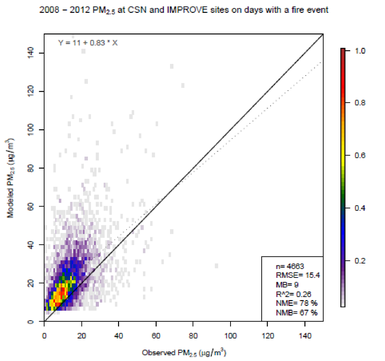


Model Performance for "Fire Event" Pairs

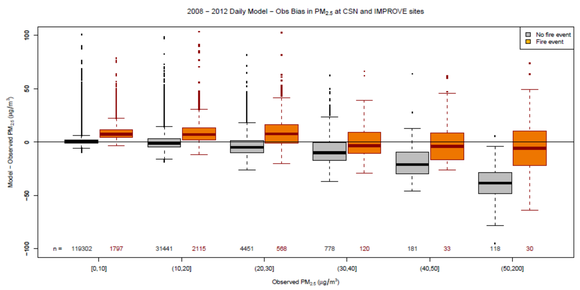
Without Fire Emissions



With Fire Emissions

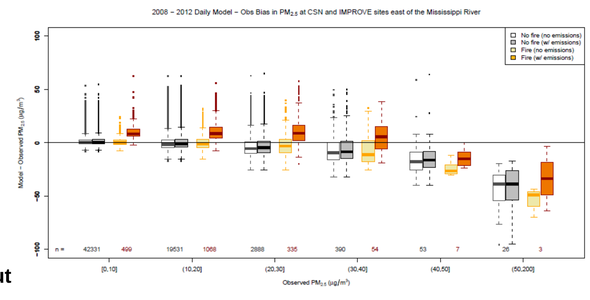


$PM_{2.5}$ Results

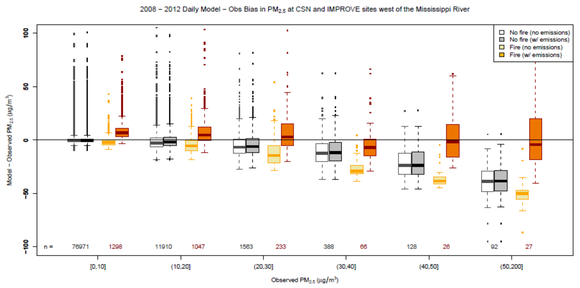


Model performance for "Fire Events" better than for "No Fire Events"

High model bias at low concentrations suggests (1) plumes are too dispersive and/or (2) small fires have too high emissions

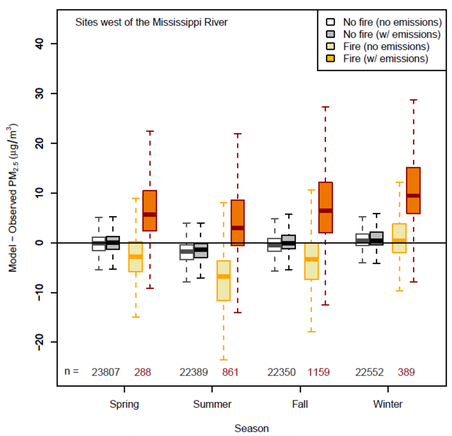


For the eastern U.S., bias is higher for lower concentrations than in the western U.S. (very few large fires in the east)

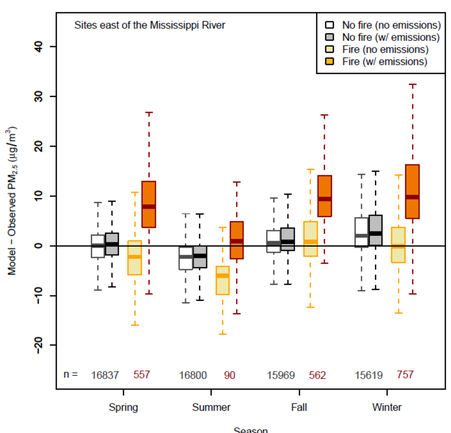


Adding fire emissions improves model performance in the western U.S., especially for higher concentrations.

2008 – 2012 Daily Model – Obs Bias in $PM_{2.5}$ at CSN and IMPROVE sites



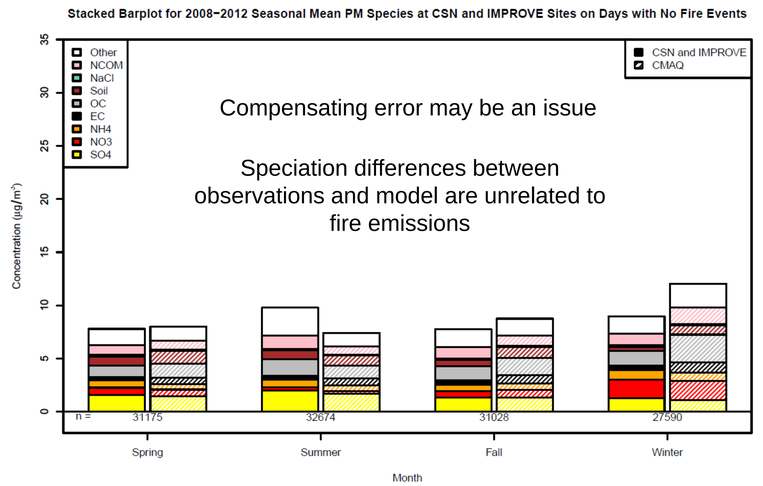
2008 – 2012 Daily Model – Obs Bias in $PM_{2.5}$ at CSN and IMPROVE sites



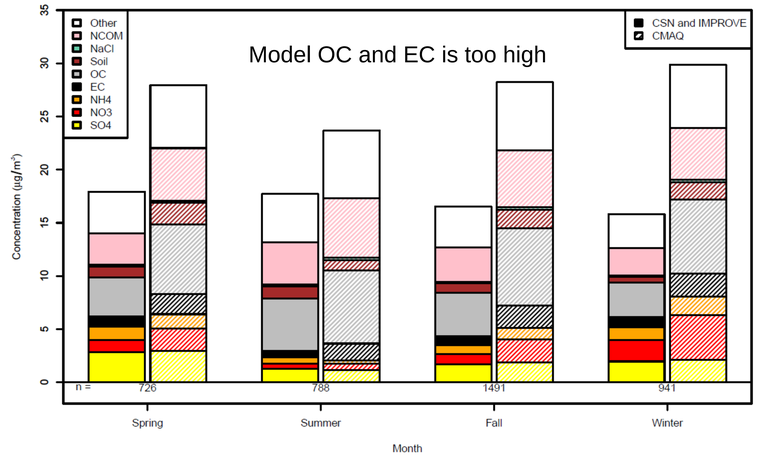
In the western U.S., improving model performance during fire events is elusive. Compensating errors appear to reduce model bias in the east during the summer. Model over predicts $PM_{2.5}$ during all seasons for fire events.

Speciation Results

Model performance for "no-fire events"



Model performance for "fire events"



Recommended Improvements

- Investigate assumption of 100 acres fire size for small fires (may be too large, especially in the eastern U.S.)
- Review plume rise to see how it affects model bias

Future Work

- Evaluate diurnal profiles at AQS sites
- Analyze model performance for ozone

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