High Resolution Simulations of Particle Sulfate Formation in Lake Breeze Fronts: Process Tracking and Implications for Forecasting.


**BAQS-Met 2007**

Measurement and modeling study with the aim of examining the interactions between long-range transport, local circulation (lake breezes) and local emissions/chemistry, in S.W. Ontario. What is the impact of the local circulation and emissions on local air-quality (versus long-range transport)? How do these gases and particles evolve downwind of a large, midlatitude urban and industrial centre (Detroit)? The aim of examining the interactions between long-range transport, local circulation (lake breezes) and local emissions/chemistry, in S.W. Ontario. What is the impact of the local circulation and emissions on local air-quality (versus long-range transport)? How do these gases and particles evolve downwind of a large, midlatitude urban and industrial centre (Detroit)?

**AURAMS**

A Unified Regional Air-quality Modelling System was used to simulate air pollution during the 27 day period June 17 to July 11, 2007. ~92% of the time in the meteorological drive. ~92% of the time in the meteorological drive. ~92% of the time in the meteorological drive.

**PM$_1$-SO$_4$ at Harrow**

Comparison to surface sites: Harrow.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Bias</td>
<td>3.789</td>
</tr>
<tr>
<td>Mean Error</td>
<td>4.592</td>
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</tbody>
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**Mass tracking of Particle Sulfate at Harrow**

(June 24th to June 26th, midnight).

What created the model PM$_1$ SO$_4$ bias at Harrow? Compare the different operators as a function of time-getting smaller for each successive graph going from left to right.

**Particle Sulphate**

- The AirSimh code includes submodels for mass tracking, the main driving force for SO$_4$ transport. A little bit of in-cloud and heterogeneous chemistry.
- Mass tracking: local circulation has a big impact on predicted concentrations!
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**Airborne AMS Measurements**

Aircraft (over all flights): R: 0.5541

Model = 1.029 Obs + 3.663

Mean Bias: 3.789

Mean Error: 4.592

The Twin Otter measurements (and certain time periods within the surface measurements) suggest that the model PM$_1$ SO$_4$ is biased high.

→What can mass tracking tell us about the possible causes for the positive bias?

An example: Flight 15.

**Investigation of different plume rise parameterizations at Harrow.**

One possible reason for the positive bias in sulphate might relate to the plume rise (hence vertical placement of sulphate precursor SO$_2$). Try a few different methods of plume rise...

The model appears to capture the SO$_2$ arriving at Harrow from the Monroe power plant fairly well, but the model sulphite arrives late and peaks too high. Changing the initial mass distribution in the plume rise changes the SO$_2$, delays the arrival of the main peak (but does not improve either SO$_2$ or PM$_1$ SO$_4$ simulations).

**Conclusions (for a work in progress):**

1. Lake breeze convergence zones have a significant impact on particulate sulphate concentrations along with forklift power-plant emission data. The model appears to capture the SO$_2$ arriving at Harrow from the Monroe power plant fairly well, but the model sulphite arrives late and peaks too high. Changing the initial mass distribution in the plume rise changes the SO$_2$, delays the arrival of the main peak (but does not improve either SO$_2$ or PM$_1$ SO$_4$ simulations).

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