

Process Tracking of Particle Sulfate Formation During the BAQS-Met Experiment in Southern Ontario

P. A. Makar¹, C. Stroud¹, J. Zhang¹, W. Gong¹, M. Moran¹, D. Sills²,
S. Gong¹, K. Hayden¹, J. Brook¹, J. Liggi¹, S.M. Li¹, J. Murphy³, J. Abbatt³, G. Evans³

¹Air Quality Research Division, Environment Canada

²Cloud Physics and Severe Weather Research Section, Environment Canada

³Chemistry Department, University of Toronto, Toronto, Canada

Keywords: Sulfate, Modelling (regional), Measurements, Aerosol Formation, AMS.

The Border Air-Quality Study – Meteorology (BAQS-Met) took place in the summer of 2007 in the southern-most part of Canada, the region bordered by Lakes Erie, St. Clair, Huron and Ontario. Aircraft and surface observations were made to determine the effects of local meteorology (land and lake breezes) on particulate matter formation. The Environment Canada AURAMS (A Unified Regional Air-Quality Modelling System) was used in forecast mode during the study to help direct aircraft and ground-based mobile laboratories. AURAMS includes size-resolved speciated particulate matter formation (12 bin sectional approach).

Subsequent to the measurement campaign, a nested version of the AURAMS model was developed to examine the impact of lake breezes on particulate matter formation. Three levels of nesting were employed: an outer nest with 42 km resolution extending over North America, a 15km intermediate grid centered over eastern North America, and a 2.5 km grid focused on the study domain. The model output on the highest resolution 2.5 km domain will be the focus of this discussion. The model shows the capability to resolve very small-scale features in the measurements, with good timing for the capture of plumes from major particulate events at fixed sites in the area, though variable ability to resolve some local features from aircraft and mobile ground-based laboratories.

A formal statistical comparison between observations and both aircraft and ground-based observations has been prepared. Figure 1 shows an example comparison between Aerosol Mass Spectrometer measured sulfate and model-predicted sulfate for the same size range, at one of the fixed super-sites in the study (Harrow). The agreement is good, with the timing of sulfate peaks and lows being well captured by the model.

An example comparison from the surface mobile laboratory CRUISER is shown in Figure 2. This is followed by a comparison of the statistics for this drive along the highway (R = correlation coefficient, B = slope, A = intercept, MB = mean bias, NMB = normalized mean bias(%), ME = mean error, NME = normalized mean error(%)).

A diagnostic package has been added to the high resolution model to track the changes in particle

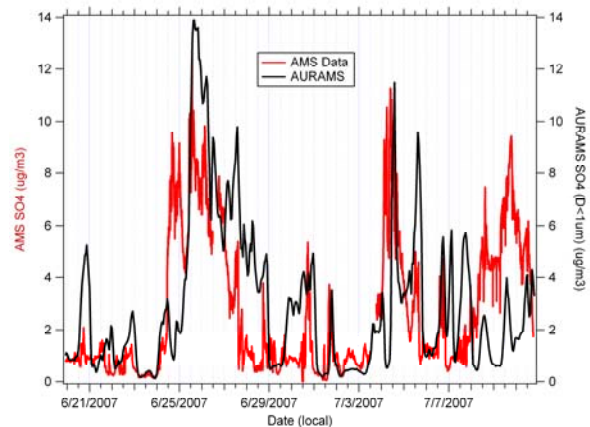


Figure 1. Comparison between AURAMS PM₁ SO₄ and AMS SO₄, Harrow.

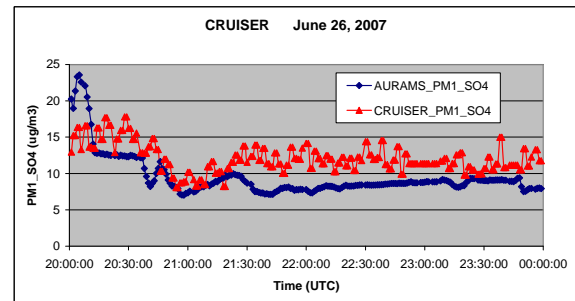


Figure 2. Comparison between AURAMS PM₁ SO₄ and AMS SO₄, CRUISER.

Table 1. Statistical analysis of comparison depicted in Figure 2.

R	B	A	MB
0.535	0.768	0.184	-2.63
NMB	ME	NME	
-21.7	3.19	26.3	

sulfate due to each of the model's chemical and physical processes. This in turn has allowed the relative importance of different model processes towards the resulting sulfate concentrations to be evaluated for different particle sizes. The relative importance of advection, diffusion, chemical formation, chemical transformation, and the different components of particle microphysics will be presented for different periods during the measurement intensive.