Modeling Size and Composition resolved Ambient Aerosol Distributions with combined SMPS and AMS data

AMS Users Meeting
2004

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Model Overview

• Fit 3 lognormal modes to ambient SMPS and AMS size distributions
  – Internally mixed (by mode)
  – Constant Shape by mode
  – Constant Collection Efficiency by Mode
• Fit in Volume equivalent diameter ($d_{ve}$)
• Lognormal Modes must be “Physical”
• Instrument Convolutions
  – Evaporation Broadening
  – Chopper Broadening
  – Lens Transmission
Data Integration Algorithm

Direct Aerosol Measurements

SMPS
- Number $(d_m)$
- “Apparent” Volume $(d_m)$
- Sulfate Mass $(d_m)$
- Nitrate Mass $(d_m)$
- Ammonium Mass $(d_m)$
- Organic Mass $(d_m)$

AMS

Predicted Aerosol Distributions

3 Lognormal Modes $(d_{m0})$
- Internal Mixture
- Parameters for each mode:
  - $N$, $d_m$, $\sigma$, $\chi$
  - Composition

Initial Guess
Minimize $\chi^2$

SMPS Volume Distribution

Pittsburgh Air Quality Study (Sept. 12, 2002)

Well Studied Day
Presents a challenge to Model
- Dynamic aerosol population
- Fractal Mode Early
- Growth of Modes

Data from Qi Zhang and Charles Stanier
Lognormal Parameters

Mode Composition

Where the error is

Overall Fit to AMS Data

Error fitting the Organic small mode
- Possible Fractal Mode
- Time Resolution of Measurements
- “Unphysical” result
2-3 AM Small Mode Organic Spike

8-9 AM Intermediate Mode Appears

10-11 AM Nucleation Mode Grows to size measurable by AMS

12-11 PM Growth of Modes 1 and 2

6-11 PM Lens Transmission of AMS???
Fit Parameters

<table>
<thead>
<tr>
<th>Mode 1</th>
<th>Mode 2</th>
<th>Mode 3</th>
<th>CO (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>1.4</td>
<td>1.2</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Mode 1

CO

Std. Deviation ($\sigma$)

Shape Factor ($\chi$)

12:00 AM 9/12/2002 6:00 AM 12:00 PM 6:00 PM 12:00 AM 9/13/2002

CE

Collection Efficiency

Accumulation Mode (Mode 3) hovers around .5 CE -> likely particle bounce
Peter Liu's measured transmission is overlaid on the data from Pittsburgh (Mode 1).

\( \text{CE}_b = 1 \) (no bounce)

\( \chi = 1 \) (Spheres)