AMS Collection Efficiencies of dry smog chamber aerosols, dependence on (NH4)2SO4, NH4NO3 and SOA fractions

Eriksson, Axel; Nordin, Erik; Nilsson, Patrik; Carlsson, Jonatan; Rissler, Jenny; Kulmala, Markku; Svenningsson, Birgitta; Pagels, Joakim; Swietlicki, Erik

Published in:
EAC 2011 proceedings

2011

Link to publication

Citation for published version (APA):

Total number of authors: 9

General rights
Unless other specific re-use rights are stated the following general rights apply:
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.
• Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
• You may not further distribute the material or use it for any profit-making activity or commercial gain
• You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: https://creativecommons.org/licenses/

Take down policy
If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
The Aerodyne Aerosol Mass Spectrometer (AMS) measures the average chemical composition of non-refractory species, i.e. particulate matter which vaporizes when impacted on a surface heated to 600 C. The instrument provides quantitative data on-line with time resolution down to seconds (dependent on mass loading). This is accomplished through mass spectrometric measurements subsequent to aerodynamic lens focusing. Each particle type (with respect to shape, size and composition) has associated collection efficiency (CE) which data analysis needs to take into account in order to yield quantitative results.

CE is a collective name for any effect on instrument sensitivity associated with particle sampling, and was given by Huffman et al. (2005) as

\[ CE(d_{wa}) = E_L(d_{wa}) \times E_s(d_{wa}) \times E_b(d_{wa}) \]

The expression above emphasizes three particle properties which may bias the sampling; lens transmission \( E_L \), non-spherical shape \( E_s \), bouncing from the vaporizer plate \( E_b \), and their possible dependence on size. \( E_L \) and \( E_s \) are close to unity for most ambient accumulation mode particles, making \( E_b \) the main contributor to uncertainty in quantification.

This study is a summary of CE estimates from inter comparison with other aerosol instrumentation (primarily Scanning Mobility Particle Sizer, SMPS, and Aerosol Particle Mass analyzer- Differential mobility Analyzer, APM-DMA) on data from two light duty vehicle exhaust ageing campaigns. The experiments were performed by nebulizing (NH₄)₂SO₄ and injecting it into a 6 m³ smog chamber, mixing with real exhaust or precursor species and irradiating the chamber with UV-light under dry (RH~5%) conditions (Nordin et al. 2011). This typically resulted in condensation of SOA and/or NH₄NO₃ (NH₃ forms in the oxidation catalyst of the vehicle), a process which was monitored for approximately 5 hours. These internally mixed aerosols spanned a wide range of chemical compositions, from pure seeds to particles dominated by either condensate, enabling investigation of the effects of these proportions on CE.

Figure 1 below illustrates one of the experiments were NH₄NO₃ and SOA condense onto (NH₄)₂SO₄ seeds. In the two hours plotted, the particles transform from salt cores lightly coated with organic matter (this coating occurred while injecting the exhaust) to heavily coated (approximately 50% SOA, 30% NH₄NO₃, and 20% (NH₄)₂SO₄) particles. During this process, the ratio of reported AMS/SMPS mass increases from 0.23 to 0.37. This is in agreement with ambient observations, where dry aerosols dominated by (NH₄)₂SO₄ typically is found to have \( E_b = 0.25 \) while dried SOA gives \( E_b = 0.5 \).

Although the increasing ratio illustrated above is mainly due to increasing \( E_b \), it should be noted that other aspects of instrumental response (in both instruments) also may affect the ratio. \( E_b \) is believed to be an effect of particle phase (Matthew et al. 2008). Ambient AMS measurements usually employ a dried sampling line (to reduce interference from gaseous and particulate water), which may perturb the phase of the sampled particles. Since these experiments were performed under dry conditions, this effect is presumably captured here.

This work was supported by the Swedish research council FORMAS through projects 2007-1205, 2008-1467 and 2010-1678

