


Supplement of Atmos. Chem. Phys., 14, 7631–7644, 2014
<http://www.atmos-chem-phys.net/14/7631/2014/>
doi:10.5194/acp-14-7631-2014-supplement
© Author(s) 2014. CC Attribution 3.0 License.



Atmospheric
Chemistry
and Physics
Open Access

The logo for the journal Atmospheric Chemistry and Physics, featuring the letters 'EG' inside a stylized globe.

Supplement of

An alternative method for estimating hygroscopic growth factor of aerosol light-scattering coefficient: a case study in an urban area of Guangzhou, South China

Z. J. Lin et al.

Correspondence to: J. Tao (taojun@scies.org)

SUPPORTING INFORMATION

Further description on the chemical analysis of OC and EC

With regard to the present study, two stages were performed in the experiments to determine carbonaceous aerosols. The first stage of carbon analysis was in an inert helium atmosphere and consisted of four temperature steps: 250 °C (60 s), 500 °C (60 s), 650 °C (60 s), and 850 °C (120 s). The second stage was conducted under an environment of 2% O₂/98% He, and the temperature was set as 550 °C (45 s), 625 °C (45 s), 700 °C (45 s), 775 °C (45 s), 850 °C (45 s), and 870 °C (120 s). Due to the non-uniform particle deposition on the filters collected by the cascade impactor, laser correction did not work properly to separate OC and EC based on this protocol. Hence, we defined OC as the fraction of carbon that evolved at or below 850 °C in a helium atmosphere (in the first stage), and EC as the fraction of carbon that evolved after oxygen was introduced to the carrier gas (in the second stage). A similar approach was applied in a previous study (Huang and Yu, 2008).

In fact, the MSP high flow impactor, with an inlet and regular stages with cut-point diameters of 18, 10, 2.5, 1.4, 1.0, 0.44 and 0.25 µm, was employed in this work to collect size-segregated aerosols. The carbonaceous aerosols in the first 2 stages (>18µm and 10-18µm) were not determined in this study because particles in these size ranges widely deposited on the filter that cannot be covered by the punch area (1.5cm²) required by the analyzer.

On the other hand, PM_{2.5} and PM₁₀ samples were also collected by two aerosol samplers (BGI Incorporated, Waltham, MA, U.S.A., Model PQ200) at the same monitoring site on November 12, 14, 16 and 18, 2010. Both samplers were operated at the flow rate of 16.7 L min⁻¹. One sampler was equipped with a PM_{2.5} cut cyclone (Model VSCC), while the other was equipped with a PM₁₀ cut cyclone. The quartz filter was analyzed for the OC/EC fractions following the IMPROVE thermal/optical reflectance (TOR) protocol on a DRI model 2001 carbon analyzer (Atmoslytic, Inc., Calabasas, CA, USA) (Chow et. al., 2007). This analysis acquired four OC fractions (OC1, OC2, OC3, and OC4 at 140 °C, 280 °C, 480 °C and 580 °C, respectively, in a helium [He] atmosphere), OP (a pyrolyzed carbon fraction determined when transmitted laser light attains its original intensity after oxygen [O₂] was added to the analysis atmosphere), and three EC fractions (EC1, EC2, and EC3 at 580 °C, 740 °C and 840 °C, respectively, in a 2% O₂/98% He atmosphere). IMPROVE_TOR OC is operationally defined as OC1 + OC2 + OC3 + OC4 + OP and EC is defined as EC1 +

EC2 + EC3 – OP (Chow et. al., 2007).

The comparison of the carbon fraction measurement results of the high flow impactor with those of BGI aerosol samplers was presented in Figure 1. Although only four data points were available for comparison, an excellent agreement was found in total carbon (TC) between the two different measurement methods. However, the bias of OC between the analysis method employed in this study and IMPROVE TOR is estimated to be about +10%, while the bias of EC is about -30%. The bias may be aroused from the different thermal gradient program and the laser correction. A sensitivity test was thus conducted to quantify the impact of the uncertainties in OC/EC separation on the b_{sp} results. It was found that a 10% variation in OC only resulted in a 3% variation in b_{sp} , while a 30% variation in EC only resulted in a 1% variation in b_{sp} . Uncertainties in b_{sp} will cause uncertainties in the calculated $f_{sp}(RH)$. As shown in Figure 2, the impact of the uncertainties from the measured mass size distributions of OC and EC should only cause no more than 3% uncertainties in the calculated $f_{sp}(RH)$ in this study.

Comparison between the primary output from ISORROPIA II and E-AIM

The extended aerosol thermodynamics model (E-AIM) (Wexler and Clegg, 2002) is another popular tool for predicting the water content and partitioning inorganic components in aerosol system. The E-AIM Model III can be found at the website:

<http://www.aim.env.uea.ac.uk/aim/aim.php> .

We once compared the primary output of ISORROPIA II with that of E-AIM Model III using the aerosol measurement results as input.

The comparison results are illustrated in Figure 3. Small differences were found in the output of NO_3^- and NH_4^+ between the two models. The obvious differences may exist in the partitioning of the amount of HSO_4^- and SO_4^{2-} . Furthermore, a good linear correlation in the estimated H_2O mass was found between the two models if excluding a few outliers. The slope of the regression (=0.81) suggests that the H_2O mass estimated by E-AIM Model III is a bit higher than that by ISORROPIA II.

We chose ISORROPIA II for our study since it meets our research demands. ISORROPIA II can help to determine aerosol composition with reasonable accuracy. Moreover, the executables of ISORROPIA II can be easily acquired from internet, the computation of ISORROPIA II is highly efficient, and it is quite suitable for batch

processing when there is a considerable amount of data.

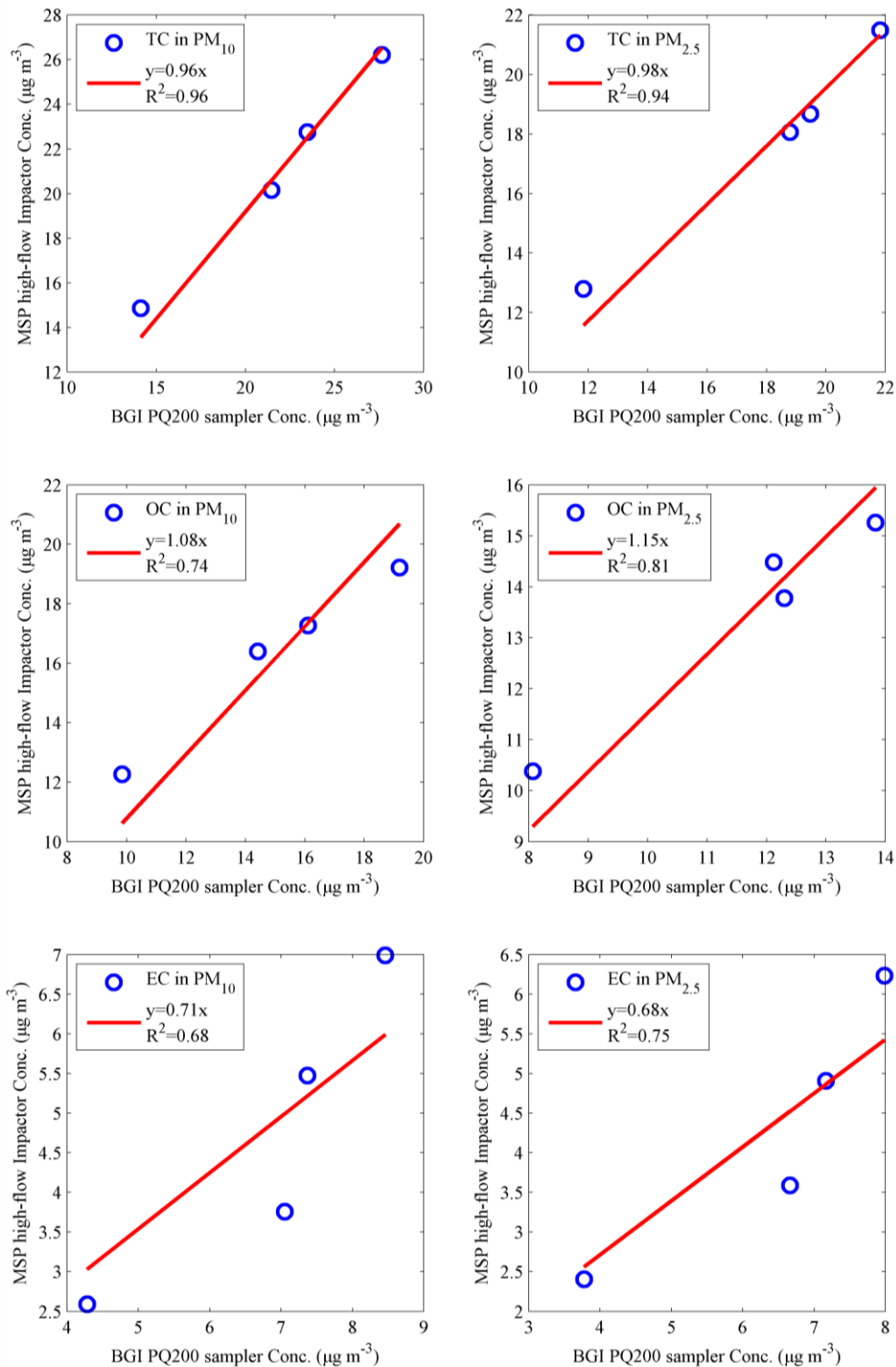


Figure 1 Comparison between the measurement results of MSP high-flow Impactor and BGI PQ200 sampler.

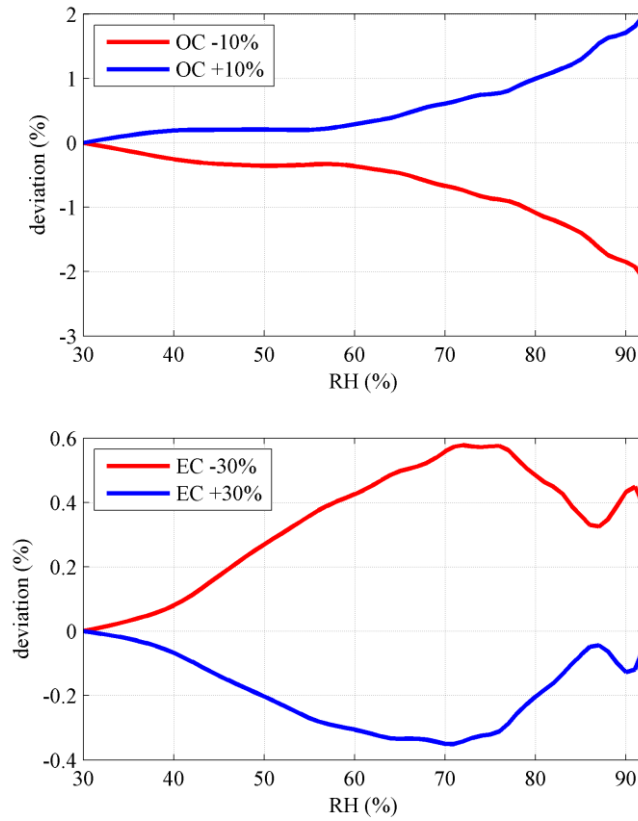


Figure 2 Deviation of $f_{sp}(RH)$ due to the bias of OC and EC

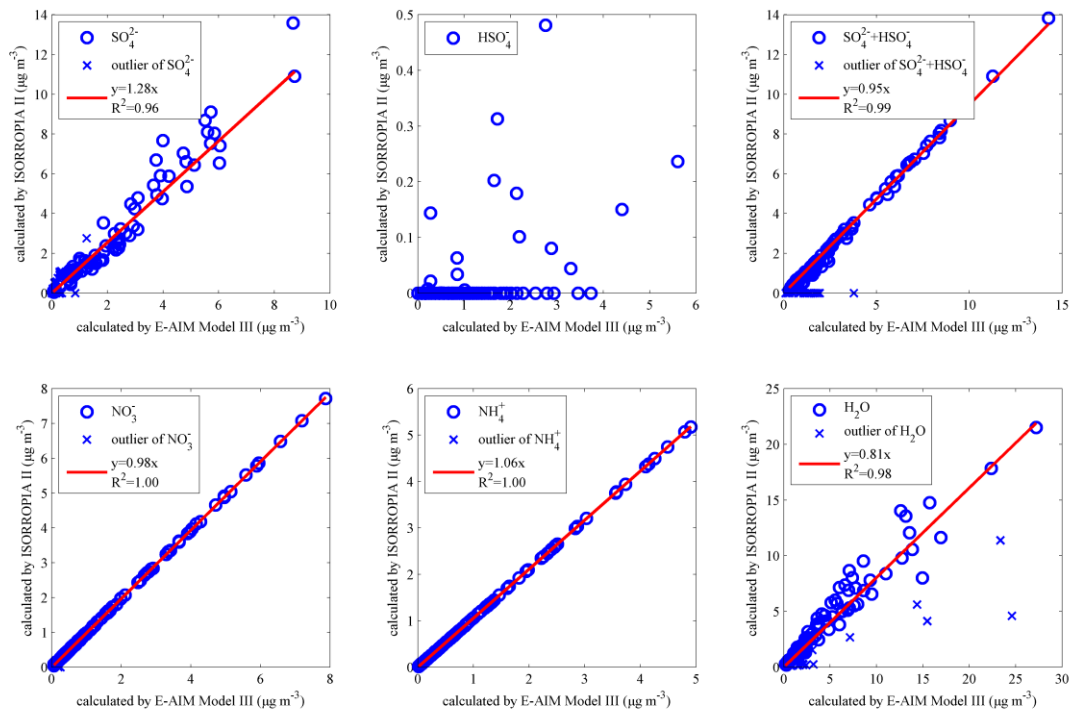


Figure 3 Comparison between the results from ISORROPIA II and E-AIM. The outlier are the points with a ratio of x-data to y-data being smaller than 0.5 or bigger than 2. The linear regressions were performed without the outliers.

References

- Chow, J. C., Watson, J. G., Chen, L. W. A., Chang, M. C. O., Robinson, N. F., Trimble, D. and Kohl, S.: The IMPROVE_A Temperature Protocol for Thermal/Optical Carbon Analysis: Maintaining Consistency with a Long-Term Database, *Journal of the Air & Waste Management Association*, 57, 1014-1023, doi: 10.3155/1047-3289.57.9.1014, 2007.
- Huang, X. F. and Yu, J. Z.: Size distributions of elemental carbon in the atmosphere of a coastal urban area in South China: characteristics, evolution processes, and implications for the mixing state, *Atmospheric Chemistry and Physics*, 8, 5843--5853, doi: 10.5194/acp-8-5843-2008, 2008.
- Wexler, A. S. and Clegg, S. L.: Atmospheric aerosol models for systems including the ions H^+ , NH_4^+ , Na^+ , SO_4^{2-} , NO_3^- , Cl^- , Br^- , and H_2O , *Journal of Geophysical Research: Atmospheres*, 107, ACH 14-1--ACH 14-14, 2002.