Supplement of Atmos. Chem. Phys., 20, 865–880, 2020
https://doi.org/10.5194/acp-20-865-2020-supplement

Supplement of

Distinct diurnal variation in organic aerosol hygroscopicity and its relationship with oxygenated organic aerosol

Ye Kuang et al.

Correspondence to: Ye Kuang (kuangye@jnu.edu.cn) and Yele Sun (sunyele@mail.iap.ac.cn)

1. Aerosol light scattering closure study

Because that measurements from dry nephelometers are used to estimate V_{tot} for $\boldsymbol{\kappa_{chem}}$ calculations and measured PNSD are used for retrieving $\kappa_{f(\mathrm{RH})}$, the measurement quality of aerosol optical properties and PNSD are important for results in this study. A closure study between measured σ_{sp} and that modelled based on measured PNSD with Mie theory (Bohren and Huffman, 2008) is first conducted to double check data quality of used datasets of σ_{sp} and PNSD. Measured σ_{sp} and σ_{bsp} by the nephelometer bears uncertainties associated with angular truncation errors and non-ideal light source (Müller et al., 2011). To achieve consistency between measured and modelled σ_{sp}, correction factors for measured σ_{sp} associated with truncation errors and non-ideal light source are calculated based on parameters for truncation and non-Lambertian illumination correction functions provided by (Müller et al., 2011). For modelling σ_{sp} and corresponding correction factors using Mie theory, BC was considered to be half externally and half core-shell mixed with other non-light-absorbing aerosol components. Refractive index and density of BC were assumed to be $1.80 - 0.54\mathrm{i}$ and $1.5\mathrm{g}\ cm^{-3}$ (Kuang et al., 2015). Refractive index of non-light-absorbing aerosol components (other than BC) was set to be $1.53 - 10^{-7}i$ (Wex et al., 2002). More details about Mie calculation please refer to Kuang et al. (2015).

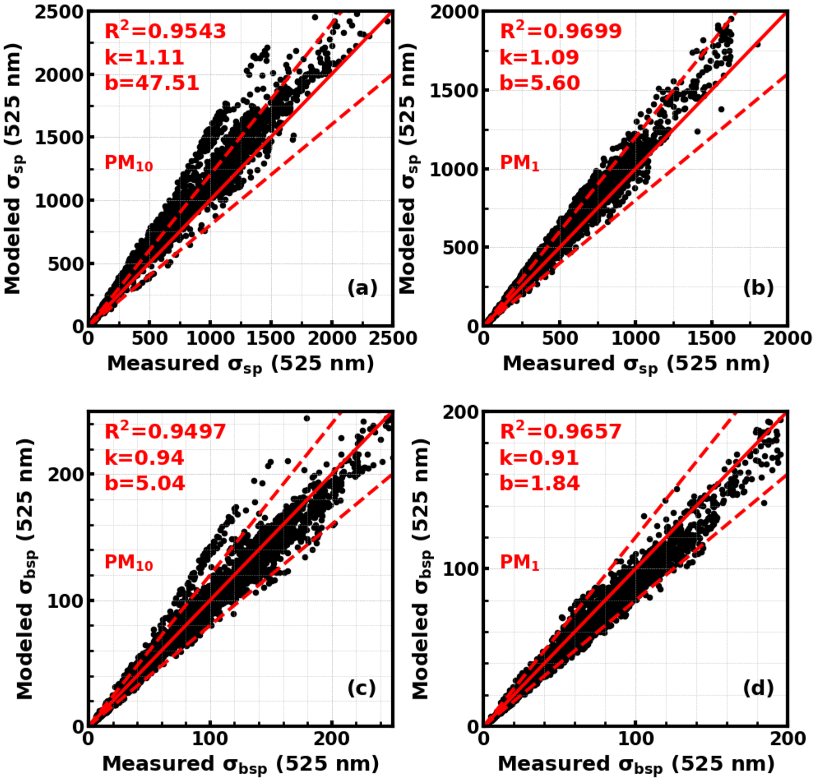

Figure S1. comparison between measured and modelled σ_{sp} and σ_{bsp} at 525 nm, solid read line is the 1:1 line, and red dashed lines are 20% relative lines.

The closure results between modelled and measured σ_{sp} and σ_{bsp} at 525 nm for PM1 and PM10 aerosol particles are shown in Fig.1. Modelled σ_{bsp} for both PM1 and PM10 agree well with the measured σ_{bsp}, and most points line between the 20% relative lines. However, Modelled σ_{sp} for both PM1 and PM10 are obviously higher than measured σ_{sp}, and the average relative difference between them for PM10 and PM1 are 22% and 13%, respectively. Considering the measured PNSD by SMPS for particles larger than 200 nm has an uncertainty range of 30% (Wiedensohler et al., 2012), and the measured σ_{sp} has an uncertainty of about 9% (Sherman et al., 2015), modelled and measured σ_{sp} and σ_{bsp} values agree well with each other during this campaign.

2. supplement figures

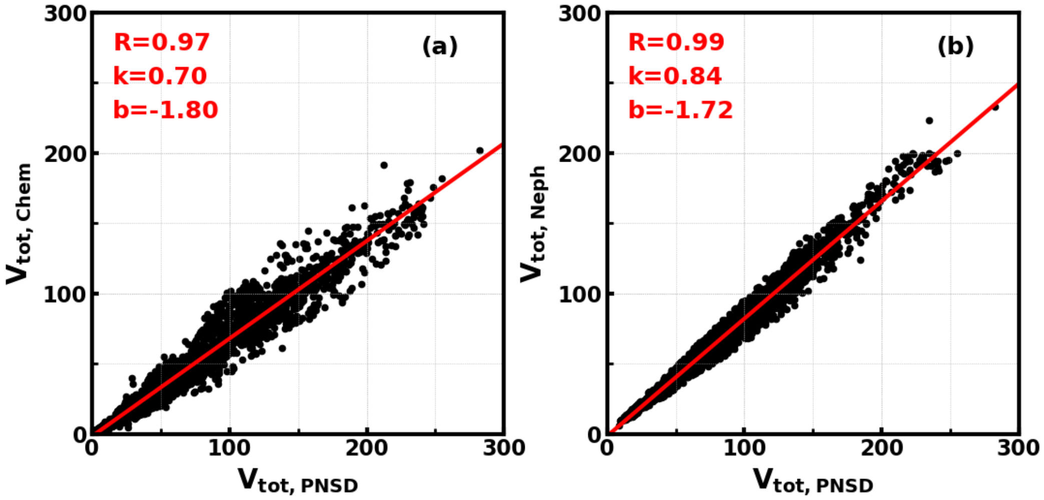

Figure S2. Comparisons between $V_{tot,PNSD}$ and $V_{tot,Chem}$ (a), $V_{tot,PNSD}$ and $V_{tot,Neph}$ (b), the unit of V_{tot} is $\mu m^3/cm^3$.

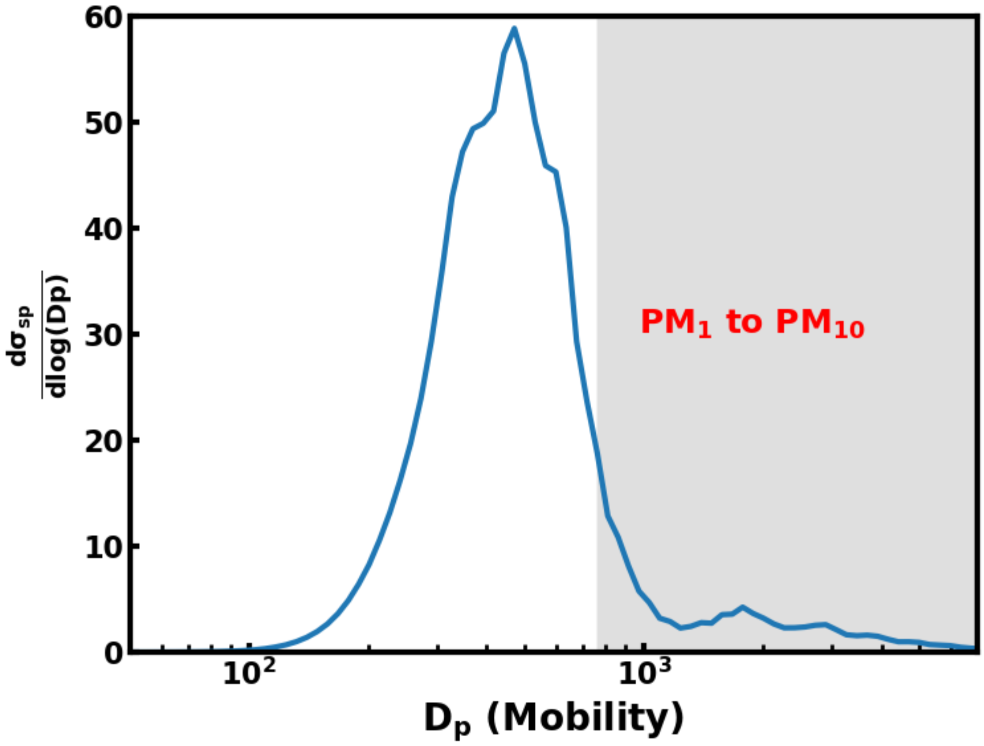

Figure S3. The size-resolved σ_{sp} contributions simulated based on the average PNSD of PM10 of period 2.

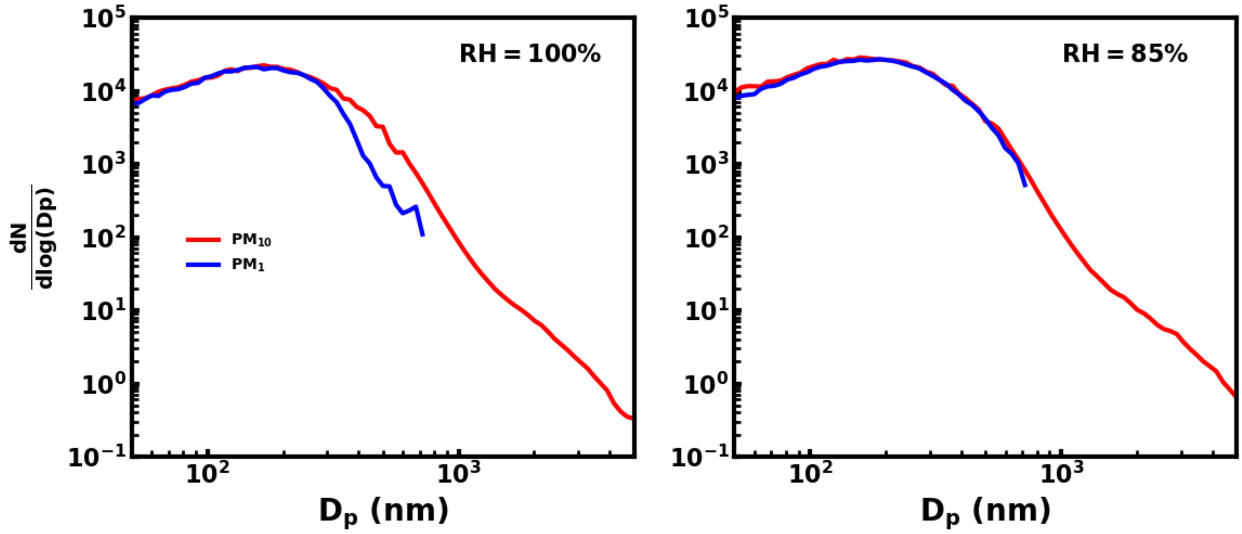

Figure S4. Examples of PNSD of PM10 and PM1 during fog events and non-fog events.

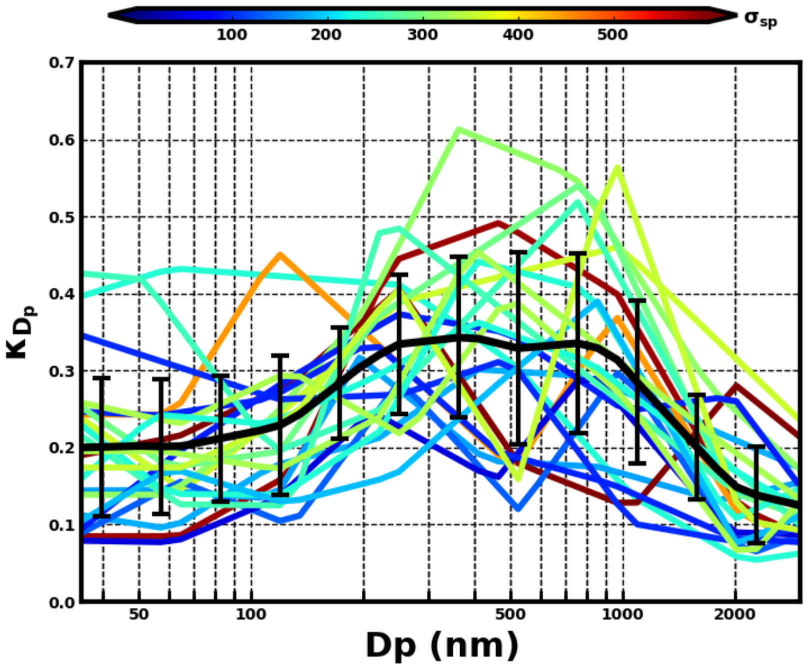

Figure S5. Size-resolved κ distributions which are derived from measured size-segregated chemical compositions during HaChi campaign, colors represent corresponding values of average σ_{sp} at 550 nm (Mm^{-1}), black solid line is the average size-resolved κ distribution and error bars are standard deviations. (reprint from (Kuang et al., 2018))

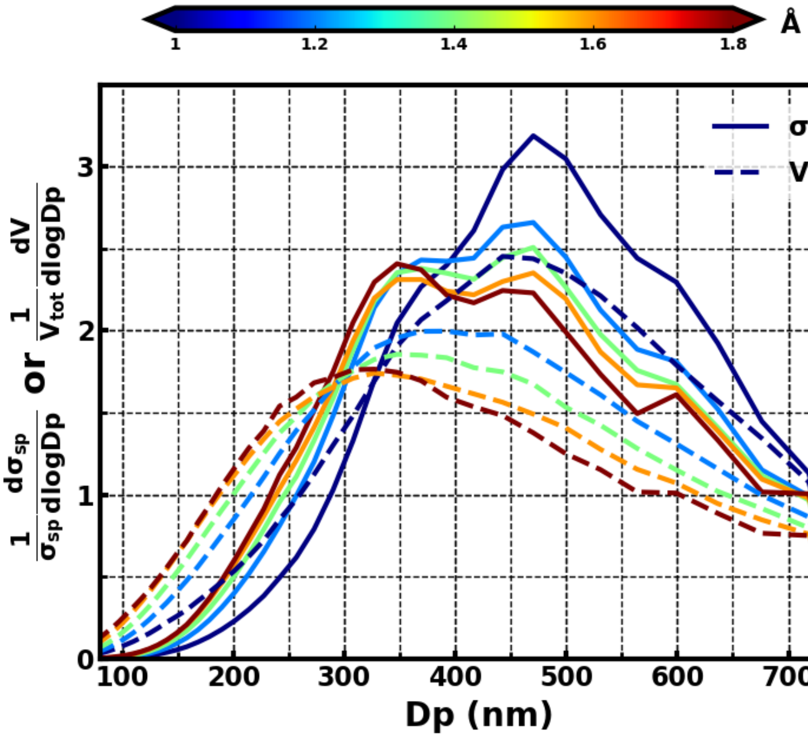

Figure S6. Normalized size-resolved volume or σ_{sp} distribution of PM_1 for average PNSDs corresponding to five ranges of aerosol Ångström exponent (0.9-1.1,1.1-1.3,1.3-1.5,1.5-1.7,1.7-1.9) during this field campaign

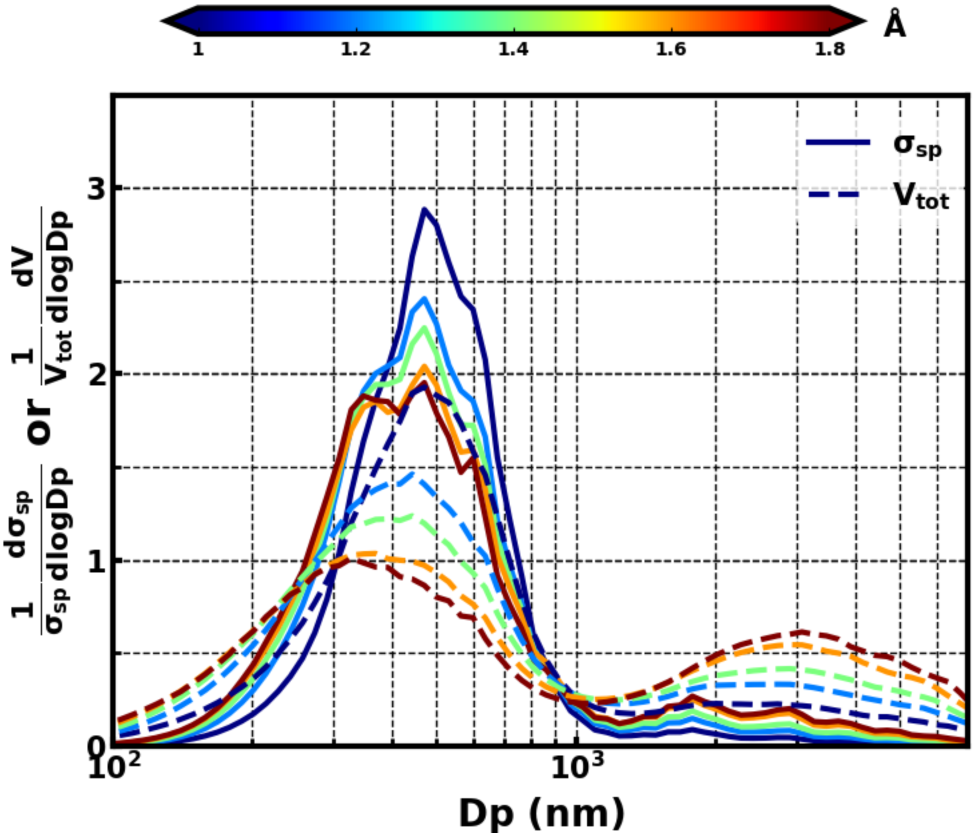

Figure S7. Normalized size-resolved volume or σ_{sp} distribution of PM$_1$ for average PNSDs corresponding to five ranges of aerosol Ångström exponent (0.9-1.1,1.1-1.3,1.3-1.5,1.5-1.7,1.7-1.9)

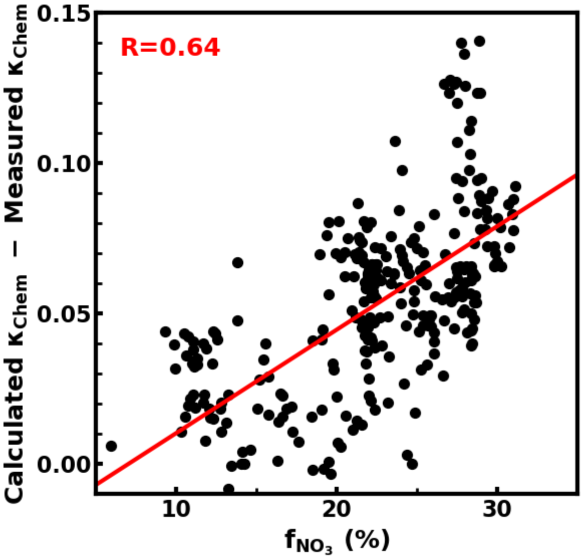

Figure S8. x-axis represents mass fraction of nitrate in NR-PM1, and y axis represents the difference between calculated and measured κ_{chem} in Period1.

Bohren, C. F., and Huffman, D. R.: Absorption and scattering of light by small particles, Wiley, New York, USA, 2008.

Kuang, Y., Zhao, C. S., Tao, J. C., and Ma, N.: Diurnal variations of aerosol optical properties in the North China Plain and their influences on the estimates of direct aerosol radiative effect, Atmos. Chem. Phys., 15, 5761-5772, 10.5194/acp-15-5761-2015, 2015.

Kuang, Y., Zhao, C. S., Zhao, G., Tao, J. C., Xu, W., Ma, N., and Bian, Y. X.: A novel method for calculating ambient aerosol liquid water content based on measurements of a humidified nephelometer system, Atmospheric Measurement Techniques, 11, 2967-2982, 10.5194/amt-11-2967-2018, 2018.

Müller, T., Laborde, M., Kassell, G., and Wiedensohler, A.: Design and performance of a three-wavelength LED-based total scatter and backscatter integrating nephelometer, Atmos. Meas. Tech., 4, 1291-1303, 10.5194/amt-4-1291-2011, 2011.

Sherman, J. P., Sheridan, P. J., Ogren, J. A., Andrews, E., Hageman, D., Schmeisser, L., Jefferson, A., and Sharma, S.: A multi-year study of lower tropospheric aerosol variability and systematic relationships from four North American regions, Atmos. Chem. Phys., 15, 12487-12517, 10.5194/acp-15-12487-2015, 2015.

Wex, H., Neususs, C., Wendisch, M., Stratmann, F., Koziar, C., Keil, A., Wiedensohler, A., and Ebert, M.: Particle scattering, backscattering, and absorption coefficients: An in situ closure and sensitivity study, Journal of Geophysical Research-Atmospheres, 107, 18, 10.1029/2000jd000234, 2002.

Wiedensohler, A., Birmili, W., Nowak, A., Sonntag, A., Weinhold, K., Merkel, M., Wehner, B., Tuch, T., Pfeifer, S., Fiebig, M., Fjäraa, A. M., Asmi, E., Sellegri, K., Depuy, R., Venzac, H., Villani, P., Laj, P., Aalto, P., Ogren, J. A., Swietlicki, E., Williams, P., Roldin, P., Quincey, P., Hüglin, C., Fierz-Schmidhauser, R., Gysel, M., Weingartner, E., Riccobono, F., Santos, S., Grüning, C., Faloon, K., Beddows, D., Harrison, R., Monahan, C., Jennings, S. G., O'Dowd, C. D., Marinoni, A., Horn, H. G., Keck, L., Jiang, J., Scheckman, J., McMurry, P. H., Deng, Z., Zhao, C. S., Moerman, M., Henzing, B., de Leeuw, G., Löschau, G., and Bastian, S.: Mobility particle size spectrometers: harmonization of technical standards and data structure to facilitate high quality long-term observations of atmospheric particle number size distributions, Atmos. Meas. Tech., 5, 657-685, 10.5194/amt-5-657-2012, 2012.