Supplement of Atmos. Chem. Phys., 18, 9061–9074, 2018
https://doi.org/10.5194/acp-18-9061-2018-supplement

Supplement of

Light absorption of brown carbon in eastern China based on 3-year multi-wavelength aerosol optical property observations and an improved absorption Ångström exponent segregation method

Jiaping Wang et al.

Correspondence to: Aijun Ding (dingaj@nju.edu.cn)

To explain the varying AAE of pure BC particles, optical interpretation is performed based on Mie-theory as shown in , where the wavelengths (λ_1 and λ_2) 370 nm and 520 nm are used as an example. Firstly, for a given two wavelengths λ_1 and λ_2, $AAE_{\lambda1\text{-}\lambda2}$ can be calculated from *Eq. 5*, where $b_{abs} = \mathrm{MAE} \cdot \frac{\pi\rho}{6} \cdot D_c{}^3$. Therefore, *Eq. 5* can be transferred into the following equation:

$$\mathrm{AAE}_{\lambda1-\lambda2} = -\frac{\ln(MAE_{\lambda1} \cdot \frac{\pi\rho}{6} \cdot D_c{}^3) - \ln(MAE_{\lambda2} \cdot \frac{\pi\rho}{6} \cdot D_c{}^3)}{\ln(\lambda1) - \ln(\lambda2)} = -\frac{\ln(MAE_{\lambda1}) - \ln(MAE_{\lambda2})}{\ln(\lambda1) - \ln(\lambda2)} \qquad \textit{Eq. S1}$$

that is, $\mathrm{AAE}_{\lambda1-\lambda2} \propto \Delta\ \ln(MAE)_{\lambda1-\lambda2}$, as shown in where MAE is plotted in logarithmic axis. When Dc << λ, the entire particle mass participates in absorption and MAE is a constant, while for Dc >> λ, only the particle's skin contributes to absorption and MAE is inversely proportional to Dc (Bond and Bergstrom, 2006; Moosmuller and Arnott, 2009), therefore, the overall changing pattern of MAE is firstly keeping steady and then drop as a function of Dc. The slight peak of MAE before dropping is due to internal resonances (Moosmüller et al., 2009). Hence, whether AAE increases or decreases with Dc can be determined by comparing the first derivative of MAE at λ_1 and λ_2 (shown in the lower axis in Figure S1), which represents the slope of MAE for each Dc. The crossing point of slope_MAE is therefore corresponding to the maximum $AAE_{\lambda1\text{-}\lambda2}$, with core size of Dc_{max}. For example, when λ_1 and λ_2 are 370 nm and 520 nm, the maximum $AAE_{370\text{-}520}$ occurs when $Dc_{max} = Dc_0 = 75$ nm. AAE increases with Dc when $Dc < Dc_0$ but decreases when $Dc > Dc_0$. Since the slope_MAE at different wavelengths are in the same shape only shifting horizontally with longer wavelength, for AAE between longer wavelengths, Dc_{max} is larger (e.g. for AAE between 520 nm-880 nm, $Dc_{max} = Dc_1 = 115$ nm,).

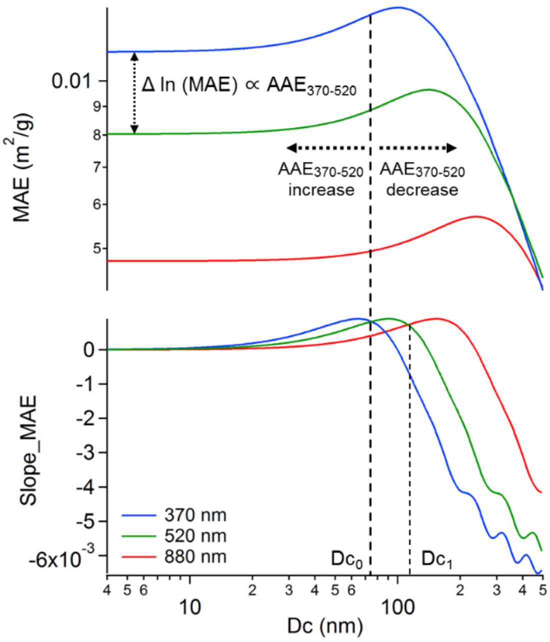

Figure S1. Variation of mass absorption efficiency (MAE) and slope of MAE (slope_MAE) vs. particle diameter (Dc) at 370 nm (λ_1), 520 nm (λ_2) and 880 nm for single pure black carbon (BC) at different Dc.

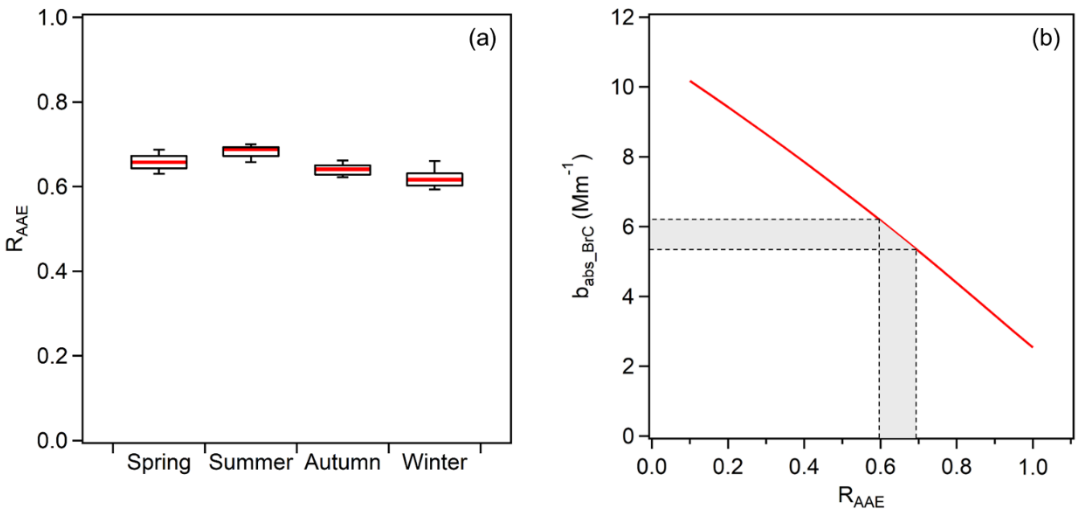

Figure S2. (a) Box plot of R_{AAE} in four seasons calculated based on SP2 data; (b) the relationship between different adopted R_{AAE} value and calculated overall mean b_{abs_BrC}. The dash lines of R_{AAE} = 0.60 and 0.69 are 5th and 95th percentile of R_{AAE} data calculated from SP2. The grey area in Y-axis therefore represents the uncertainty range of b_{abs_BrC}

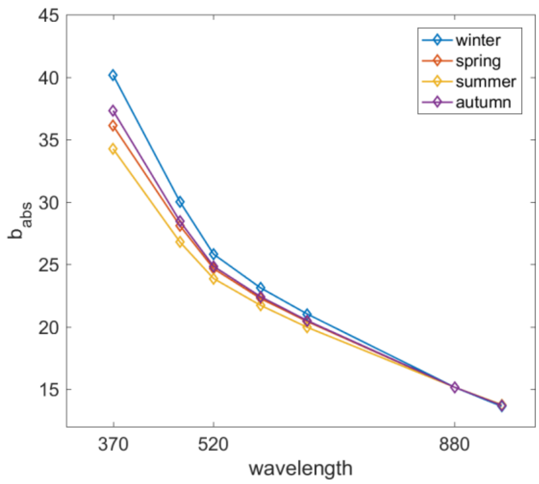

Figure S3. Scatter plot of seasonal mean b_{abs} from Aethalometer, data points are normalized using b_{abs} 880 nm

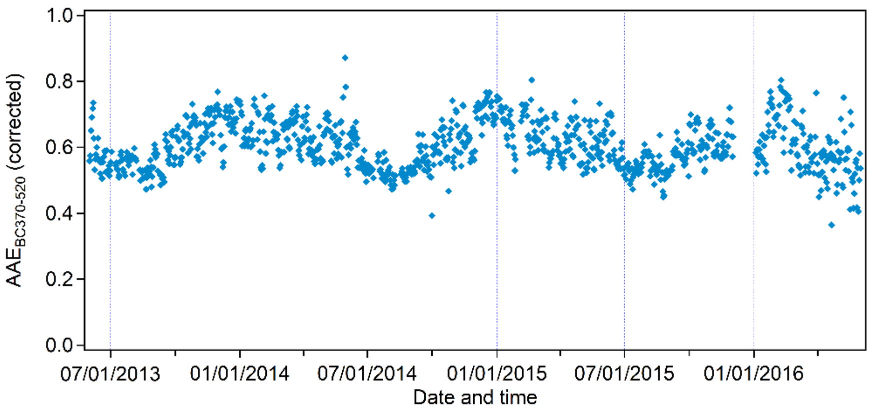

Figure S4. Time series of corrected AAE_{BC} at 370-520 nm

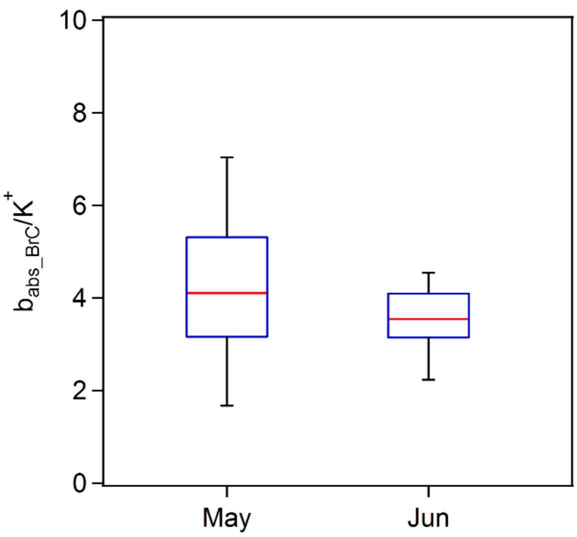

Figure S5. Significant difference result of b_{abs_BrC}/K^{+} in May and June (data is all from the year 2014)

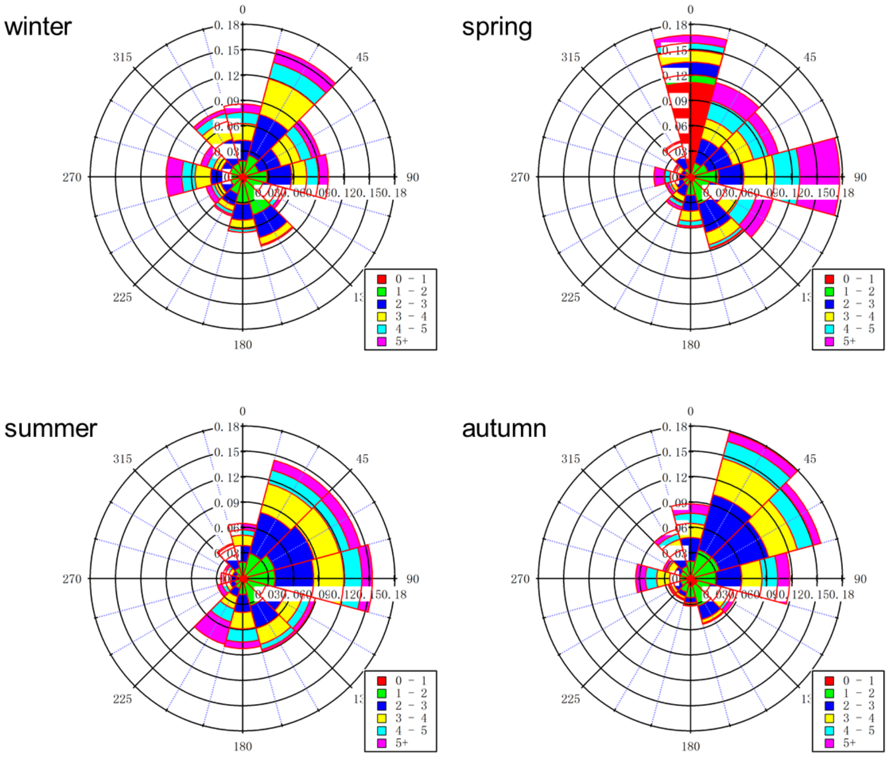

Figure S6. Wind roses at the SORPES station in four seasons

References

Bond, T. C., and Bergstrom, R. W.: Light Absorption by Carbonaceous Particles: An Investigative Review, Aerosol Sci. Technol. , 40, 27-67, 10.1080/02786820500421521, 2006.

Moosmüller, H., Chakrabarty, R. K., and Arnott, W. P.: Aerosol light absorption and its measurement: A review, J. Quant. Spectrosc. Radiat. Transfer 110, 844-878, doi:10.1016/j.jqsrt.2009.02.035, 2009.

Moosmuller, H., and Arnott, W. P.: Particle optics in the Rayleigh regime, J. Air Waste manage., 59, 1028-1031, doi:10.3155/1047-3289.59.9.1028, 2009.