

1 Supporting Information For:

2 **Aerodynamic size-resolved composition and cloud**
3 **condensation nuclei properties of aerosols in Beijing**
4 **suburban region**

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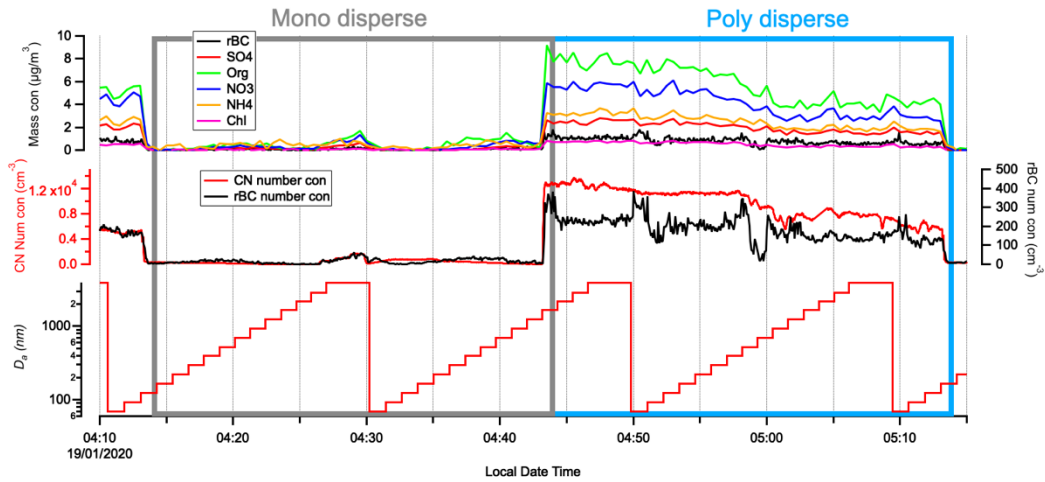
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28 **S1. The instruments overview**



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30 Figure S1. Example of a running cycle.

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33 The size bins with D_a below 90 nm and above 1100 nm is excluded in this study since
 34 it is beyond the detection range of SP2 and AMS. The peak of aerosol concentrations
 at the end of each scan is caused by the purge and transition period of the AAC.

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36 **S2. Calculation of aerosol properties parameters**

37 The particle density of all and non-refractory (NR) particles are calculated through:

38
$$\rho_{\text{all}} = \frac{M_{\text{all}}}{V_{\text{all}}} \quad (1)$$

39
$$\rho_{\text{NR}} = \frac{M_{\text{NR}}}{V_{\text{NR}}} \quad (2)$$

40 Where M_{all} is the mass concentration of all particles from the AMS and SP2 results,
 41 V_{all} is derived through the mass concentration of each measured composition mass
 42 concentration and the material density shown in Table S1. The calculation of ρ_{NR} is

43 similar to the calculation of ρ_{all} , but only NR compositions from AMS are included
 44 here.

45 The particle density of rBCc is derived by:

$$46 \quad \rho_{\text{rBCc}} = \frac{M_{\text{rBCc}}}{V_{\text{rBCc}}} = \frac{\rho_{\text{NR}} \cdot \left(\frac{1}{6} \pi D_{\text{p,rBCc}}^3 - \frac{1}{6} \pi D_{\text{c}}^3 \right) + M_{\text{rBC}}}{\frac{1}{6} \pi D_{\text{p,rBCc}}^3} \quad (3)$$

47 where M_{rBCc} and V_{rBCc} are the mass and volume of the rBCc respectively, the density
 48 of rBCc coating is assumed to be the same as bulk non-refractory particle density. The
 49 rBC core diameter (D_{c}) and total rBCc diameter ($D_{\text{p,rBCc}}$) are derived through the SP2
 50 LEO method.

51 The average single particle mass for all particles and rBCc is calculate by:

$$52 \quad M_{\text{single,all}} = \frac{M_{\text{all}}}{N_{\text{total}}} \quad (4)$$

$$53 \quad M_{\text{single,rBCc}} = \frac{M_{\text{rBCc}}}{N_{\text{rBCc}}} \quad (5)$$

54 Where N_{total} and N_{rBCc} is the number concentration for total CN and rBCc respectively.

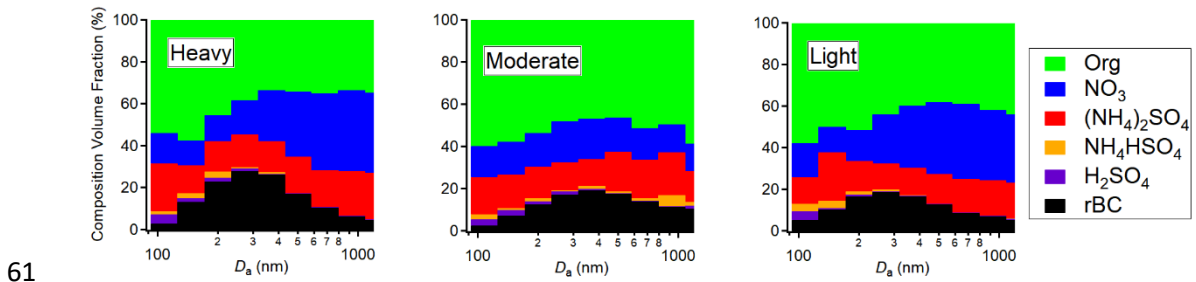
55 Then the volume equivalent diameter of all particle is assumed to equal to the mass
 56 equivalent diameter:

$$57 \quad D_{v,\text{all}} = D_{m,\text{all}} = \sqrt[3]{\frac{6M_{\text{single,all}}}{\rho_{\text{all}} \cdot \pi}} \quad (6)$$

58 The shape factor is derived from:

$$59 \quad \chi = \frac{\rho_{\text{p}} D_{\text{v}}^2 C_{\text{c}}(D_{\text{v}})}{D_{\text{a}}^2 C_{\text{c}}(D_{\text{a}})} \quad (7)$$

60 **S3. The size-resolved aerosol composition volume fractions**



62 Figure S2 Composition volume fractions under different pollution level

63

64 **S4. The simplified ion pairing scheme**

65 Details about this ion pairing scheme is discussed in Gysel et al(Gysel et al., 2007), the
66 solutions are expressed as below:

67
$$n_{\text{NH}_4\text{NO}_3} = n_{\text{NO}_3^-}$$

68
$$n_{\text{H}_2\text{SO}_4} = \max(0, n_{\text{SO}_4^{2-}} - n_{\text{NH}_4^+} + n_{\text{NO}_3^-})$$

69
$$n_{\text{NH}_4\text{HSO}_4} = \min(2n_{\text{SO}_4^{2-}} - n_{\text{NH}_4^+} + n_{\text{NO}_3^-}, n_{\text{NH}_4^+} - n_{\text{NO}_3^-})$$

70
$$n_{(\text{NH}_4)_2\text{SO}_4} = \max(n_{\text{NH}_4^+} - n_{\text{NO}_3^-} - n_{\text{SO}_4^{2-}}, 0)$$

71
$$n_{\text{HNO}_3} = 0$$

72 where n represents the number of moles for each component.

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77 **S5. Density and hygroscopicity parameter for each composition**

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	Density (kg/m ³)	κ
NH ₄ NO ₃	1720	0.67 (Petters and Kreidenweis, 2007)
(NH ₄) ₂ SO ₄	1769	0.61 (Petters and Kreidenweis, 2007)
(NH ₄)HSO ₄	1780	0.65 (Petters and Kreidenweis, 2007)
H ₂ SO ₄	1830	0.90 (Petters and Kreidenweis, 2007)
Organics (Org)	1400	0.29*(O:C ratio) (Chang et al., 2010)
Black Carbon (BC)	1800	0

79

80 Table S1. The material density and hygroscopicity parameter (κ) used for calculation.

81

82 **S6. Mass absorption coefficient calculation**

83 The mass absorption coefficient of rBCc at 880 nm (MAC₈₈₀) is calculated by using the
84 core-shell Mie theory approach(Bohren and Huffman, 2008). The refractive index of
85 coating material is assumed to be $1.5 - 0i$, and the refractive index of rBC core is
86 assumed to be $2.26 - 1.26i$ (Taylor et al., 2020). The coating material of rBCc is
87 assumed to be non-absorbing. Both coated and uncoated cases are calculated to present
88 the absorption enhancement from lensing effect of coatings at different size.

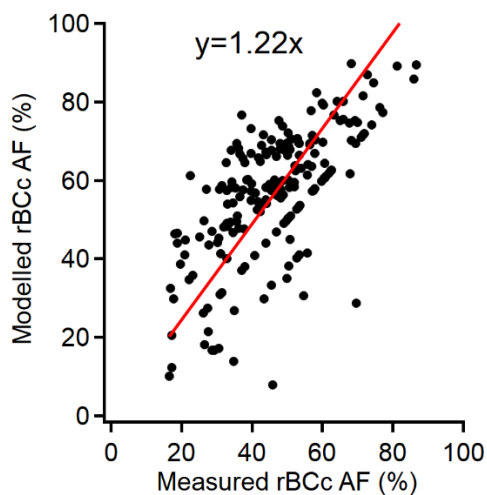
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93 **S7. Correlation between measured and modelled rBCc activation**

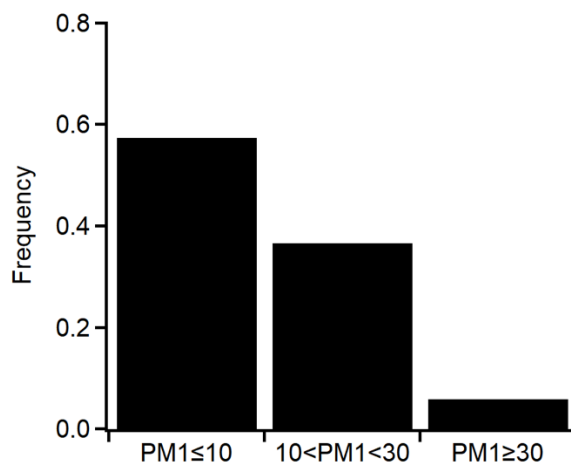


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95 Figure S3 Correlation between measured and modelled rBCc activation fraction (AF)
96 using Orthogonal Distance Regression (ODR) fitting method.

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98 **S8. PM₁ frequency distribution**



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100 Figure S4 Frequency distribution of PM₁ concentrations

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102 **References**

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