Supporting Information for

Water-insoluble organic carbon in $PM_{2.5}$ over China: light-absorbing properties, potential sources, radiative forcing effects and possible light-absorbing continuum

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Content: 7 pages, 1 text, 2 tables, and 3 figures

Text S1. Calculation of MAC for particulate light-absorbing OC

MAC can be compared with MAE only after considering the particulate effect (ξ) and in the small-particle limit (diameter << λ) (Sun et al., 2007):

$$\mathrm{MAC}(\lambda) = \mathrm{MAE}(\lambda) \times \xi(\lambda) \qquad \text{(S1)}$$

$$\xi(\lambda) = \frac{9n}{(n^2 - k(\lambda)^2 + 2) + 4n^2 k(\lambda)^2} \qquad \text{(S2)}$$

where n and k represent the real and imaginary parts of the complex refractive index ($m = n + ik$), respectively. In this study, we assume a constant n value of 1.55 (Lu et al., 2015), and the wavelength-dependent k is calculated as:

$$k\,(\lambda) = \frac{\rho \times \lambda \times \mathrm{MAE}(\lambda)}{4\pi \times \left(\frac{OA}{OC}\right)} \qquad \text{(S3)}$$

where ρ is the density of particle and was fixed to 1.2 g/cm^3. The OA/OC ratios are 1.51, 1.91, 2.30 for WIOC, HULIS and non-HULIS, respectively (Kiss et al., 2002).

Table S1. Summary of concentration and light absorption of extractble organic carbon components in $PM_{2.5}$ from ten Chinese cities

Component	Unit	Warm seasons rang (avg[a] ± std[b])	Cold seasons rang (avg ± std)	Annual avg ± std
WIOC	μgC/m^3	1.45−5.25 (2.29 ± 0.95)	1.93−12.9 (4.87 ± 2.89)	3.65 ± 2.53
HULIS-C		1.37−4.31 (2.46 ± 0.77)	2.10−7.64 (4.63 ± 1.49)	3.60 ± 1.62
Non-HULIS-C[c]		1.28−5.61 (2.36 ± 1.16)	1.55−7.96 (4.09 ± 1.51)	3.27 ± 1.60
EX-OC[d]		4.19−12.8 (7.11 ± 2.38)	6.25−25.2 (13.6 ± 5.22)	10.5 ± 5.23
$Abs_{365, WIOC}$	Mm^{-1}	1.27−7.69 (2.76 ± 1.77)	2.78−38.5 (10.4 ± 8.69)	6.80 ± 7.44
$Abs_{365, HULIS}$		1.04−6.05 (2.96 ± 1.4)	2.27−17.2 (8.72 ± 3.75)	5.99 ± 4.08
$Abs_{365, non-HULIS}$		0.53−2.72 (1.25 ± 0.68)	1.11−8.50 (3.76 ± 2.27)	2.57 ± 2.11
$Abs_{365, EX-OC}$		3.24−16.1 (6.98 ± 3.54)	6.42−55.4 (22.9 ± 13.0)	15.4 ± 12.6
WIOC/EX-OC	%	15.4−48.7 (32.5 ± 6.97)	19.8−57.5 (34.2 ± 8.12)	33.4 ± 7.55
HULIS-C/EX-OC		25.2−45.4 (35.1 ± 5.29)	19.2−47.6 (35.3 ± 6.32)	35.2 ± 5.77
Non-HULIS-C/EX-OC		21.1−43.8 (32.4 ± 5.92)	23.4−36.6 (30.5 ± 4.34)	31.4 ± 5.17
$Abs_{365, WIOC}$/$Abs_{365, EX-OC}$		20.3−50.6 (38.4 ± 9.06)	29.4−69.6 (42.5 ± 10.1)	40.5 ± 9.73
$Abs_{365, HULIS-C}$/$Abs_{365, EX-OC}$		32.2−55.1 (42.8 ± 6.54)	22.5−57.9 (40.5 ± 7.90)	41.6 ± 7.28
$Abs_{365, non-HULIS-C}$ / $Abs_{365, EX-OC}$		9.51−26.8 (18 ± 4.43)	6.80−30.4 (17.0 ± 5.58)	17.5 ± 5.02

[a] avg: average

[b] std: standard deviation

[c] The concentration of non-HULIS-C is calculated by the difference between WSOC and HULIS-C

[d] The concentration of extractable organic carbon (EX-OC) is the sum of WSOC and WIOC.

Table S2. The person correlation coefficients (r) of concentrations and Abs_{365} of WIOC with water soluble ions in cold and warm seasons.

	Concentrations of WIOC		Abs_{365} of WIOC	
	Warm seasons	Cold seasons	Warm seasons	Cold seasons
K^+	0.04	0.61**	0.25	0.48*
Cl-	0.46	0.92**	0.63**	0.90**
NO_3^-	0.38	0.29	0.53*	0.18
SO_4^{2-}	0.44	0.69**	0.51*	0.63**
NH_4^+	0.51*	0.51*	0.59*	0.49*

* Significance at $p < 0.05$ level

** Significance at $p < 0.01$ level

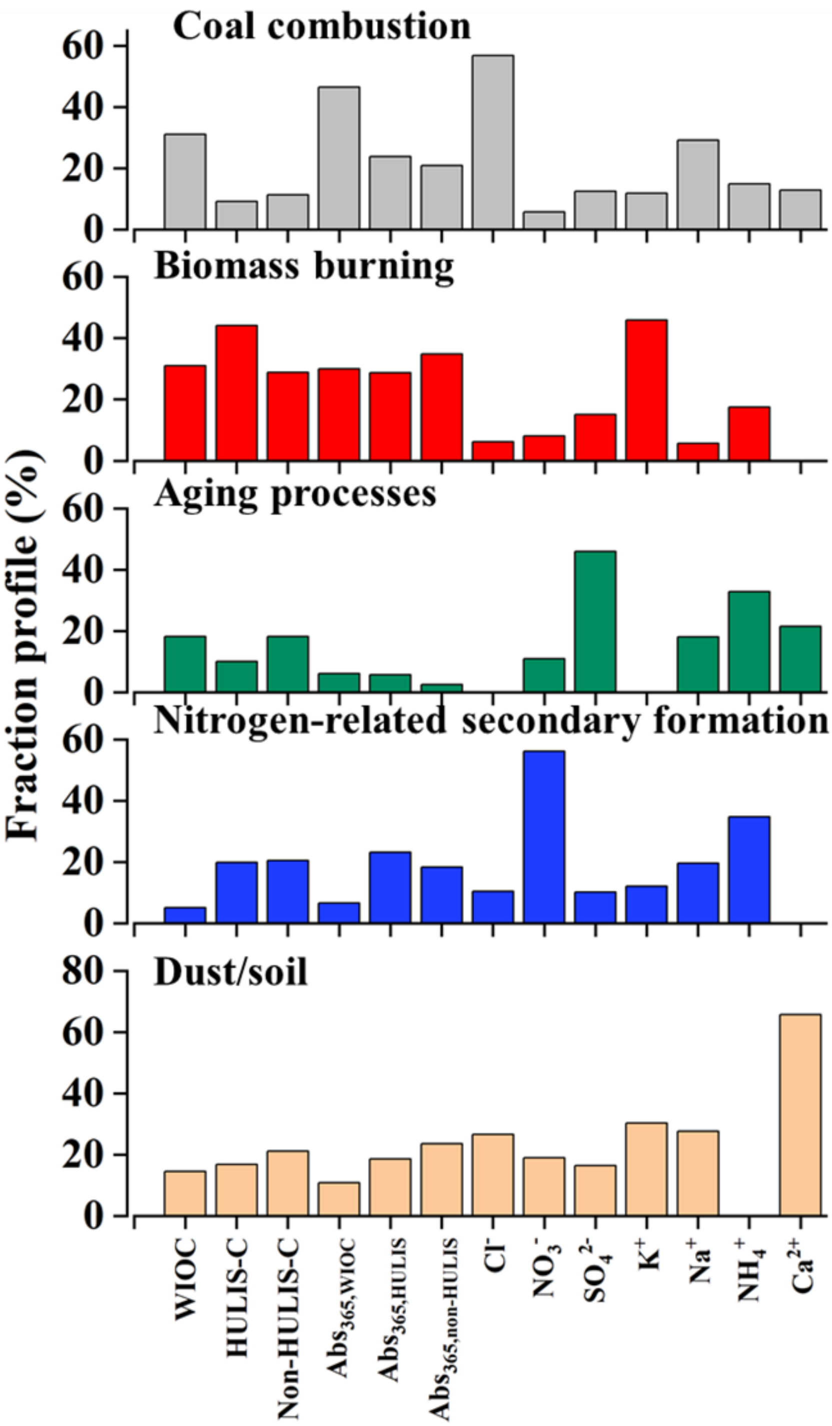

Figure S1. Source profiles for five sources resolved by the positive matrix factorization (PMF) model.

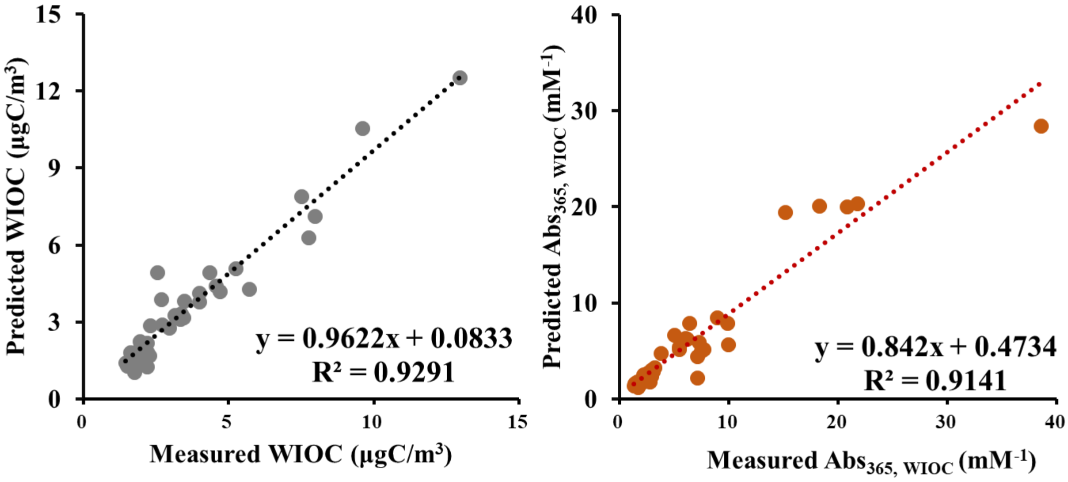

Figure S2. PMF-predicted versus measured values of (a) concentrations and (b) Abs_{365} of WIOC.

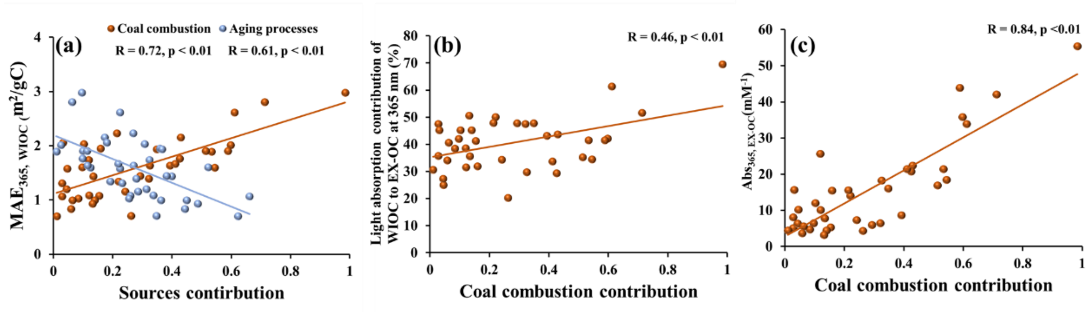

Figure S3. (a) The correlation of mass absorption efficient (MAE365) of WIOC to relative contribution of coal combustion (brown dots) and aging processes (blue dots). (b) The relationship between relative contribution of coal combustion and light absorption contribution of WIOC to EX-OC at 365 nm. (c) The relationship between relative contribution of coal combustion and light absorption of EX-CO at 365 nm.

References:

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