

1 *Supporting information*

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3 The characteristics of atmospheric brown carbon in Xi'an,  
4 inland China: sources, size distributions and optical properties

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49 **Figure caption**

50 Fig. S1 Temporal variations of levoglucosan, PAHs, OPAHs, and nitrophenols during winter  
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53 Fig. S2 Comparison of levoglucosan/mannosan and levoglucosan/galactosan ratios between  
54 biomass fuel and the samples of this study. Hardwoods cited from Fine et al. (2004a,  
55 2004b);Bari et al. (2010), softwood cited from Fine et al. (2004a, 2004b);Bari et al. (2010),  
56 needles derived from Sullivan et al. (2014);Engling et al. (2006), leaves derived from Sullivan  
57 et al. (2014);Schmidl et al. (2008), rice straw cited from Sheesley et al. (2003);Yan et al.  
58 (2015), wheat straw derived from Yan et al. (2015).

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60 Fig. S3 A comparison on the results measured by Anderson ( $D_p < 2.1\mu m$ ) and the  $PM_{2.5}$  filter  
61 samples.

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63 Fig. S4 Temporal variations of PAHs/OC and levoglucosan/OC during the haze period of  
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66 Fig. S5 Regression analysis for PAHs, OPAHs, nitrophenols, EC, and visibility. (a) PAHs,  
67 OPAHs, nitrophenols, and EC vs. visibility, (b) PAHs/EC, OPAHs/EC, and nitrophenols/EC  
68 vs. visibility.

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Table S1 Correlation coefficients between  $\text{abs}_{\lambda=365\text{nm}}$  and organic carbon species during sampling periods.

	$\text{abs}_{\lambda=365\text{nm}}\text{-MeOH}$	
	Winter	Summer
Levogluconan	0.97	0.54
PAHs	0.90	0.53
OPAHs	0.94	0.74
Nitrophenols	0.80	0.60

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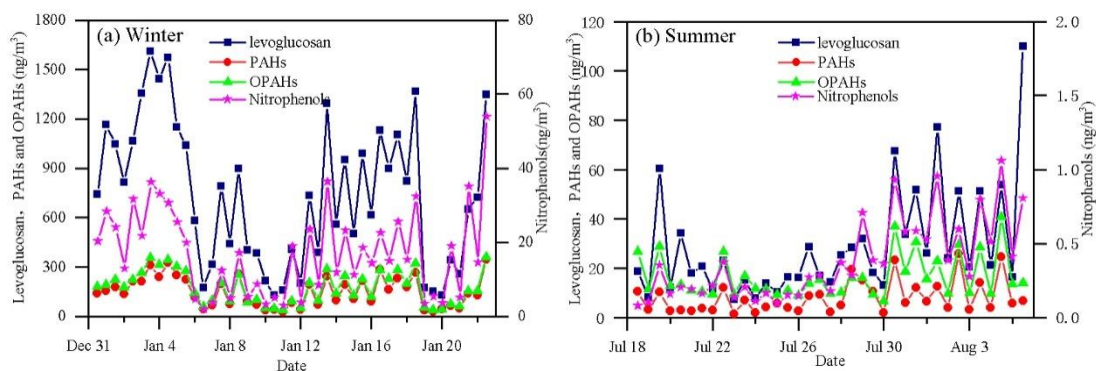
Note: all data are significant at the 0.01 level

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Table S2 Values of  $Q_{\text{true}}$ ,  $Q_{\text{robust}}$  and average  $r^2$  for the modeling results during sampling periods.

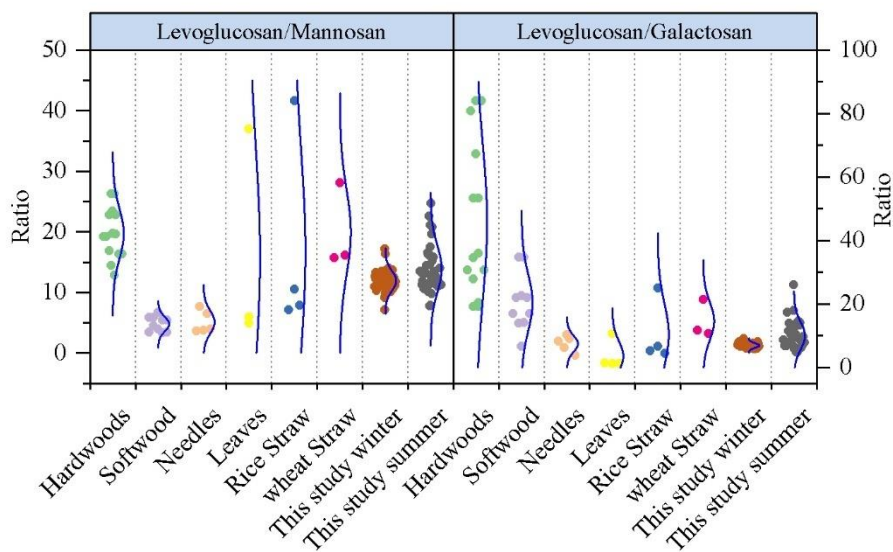
	$Q_{\text{true}}$	$Q_{\text{robust}}$	Average $r^2$
Sampling periods	724	718.7	0.96

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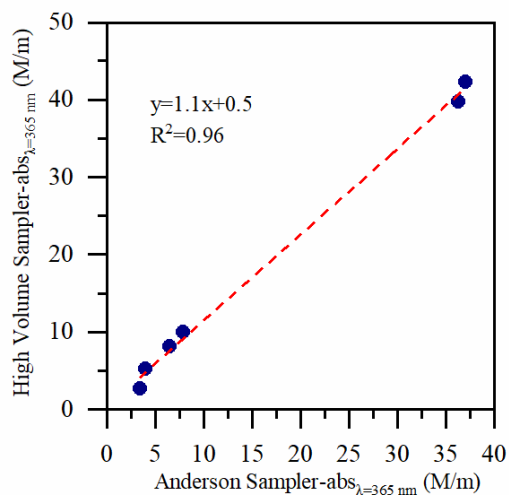
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Fig. S1 Temporal variations of levoglucosan, PAHs, OPAHs, and nitrophenols during winter and summer.



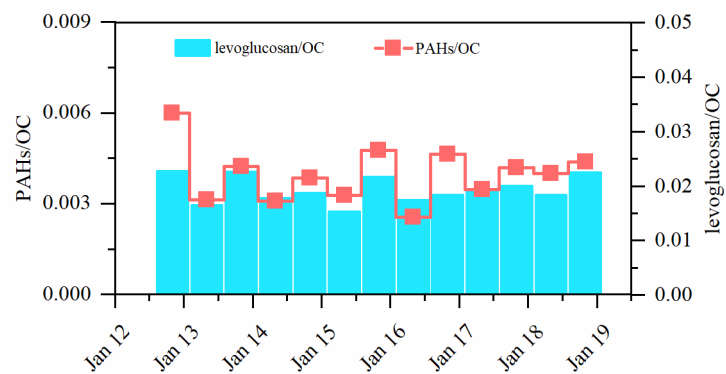
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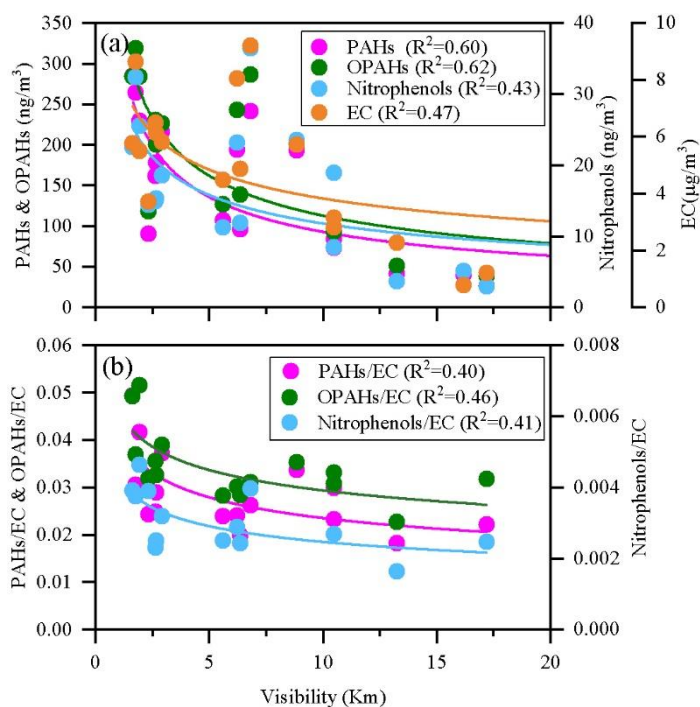
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### References

129 Bari, M. A., Baumbach, G., Kuch, B., and Scheffknecht, G.: Temporal variation and impact of wood  
130 smoke pollution on a residential area in southern Germany, Atmospheric Environment, 44,  
131 3823-3832, 2010.

132 Engling, G., Carrico, C., Krelidenweis, S., Collett, J., Day, D. W., Lincoln, E., Hao, W., Iinuma, Y., and

133 Herrmann, H.: Determination of levoglucosan in biomass combustion aerosol by  
134 high-performance anion-exchange chromatography with pulsed amperometric detection,  
135 Atmospheric Environment, 40, 299-311, 2006.

136 Fine, P. M., Cass, G. R., and Simoneit, B. R. T.: Chemical characterization of fine particle emissions  
137 from the fireplace combustion of wood types grown in the Midwestern and Western United States,  
138 Environmental Engineering Science, 36, 387-409, 2004a.

139 Fine, P. M., Cass, G. R., and Simoneit, B. R. T.: Chemical characterization of fine particle emissions  
140 from the wood stove combustion of prevalent United States tree species, Environmental  
141 Engineering Science, 21, 705-721, 2004b.

142 Schmidl, C., Bauer, H., Dattler, A., Hitzenberger, R., Weissenboeck, G., Marr, I. L., and Puxbaum, H.:  
143 Chemical characterisation of particle emissions from burning leaves, Atmospheric Environment,  
144 42, 9070-9079, 2008.

145 Sheesley, R. J., Schauer, J. J., Chowdhury, Z., Cass, G. R., and Simoneit, B. R. T.: Characterization of  
146 organic aerosols emitted from the combustion of biomass indigenous to South Asia, Journal of  
147 Geophysical Research: Atmospheres, 108, n/a-n/a, 10.1029/2002jd002981, 2003.

148 Sullivan, A. P., May, A. A., Lee, T., McMeeking, G. R., Kreidenweis, S. M., Akagi, S. K., Yokelson, R.  
149 J., Urbanski, S. P., and Collett Jr, J. L.: Airborne characterization of smoke marker ratios from  
150 prescribed burning, Atmospheric Chemistry and Physics, 14, 10535-10545,  
151 10.5194/acp-14-10535-2014, 2014.

152 Yan, C., Zheng, M., Sullivan, A. P., Bosch, C., Desyaterik, Y., Andersson, A., Li, X., Guo, X., Zhou, T.,  
153 and Örjan, G.: Chemical characteristics and light-absorbing property of water-soluble organic  
154 carbon in Beijing: Biomass burning contributions, Atmospheric Environment, 121, 4-12, 2015.

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