SUPPLEMENTARY INFORMATION

Insight into $PM_{2.5}$ Sources by Applying Positive Matrix Factorization (PMF) at an Urban and Rural Site of Beijing

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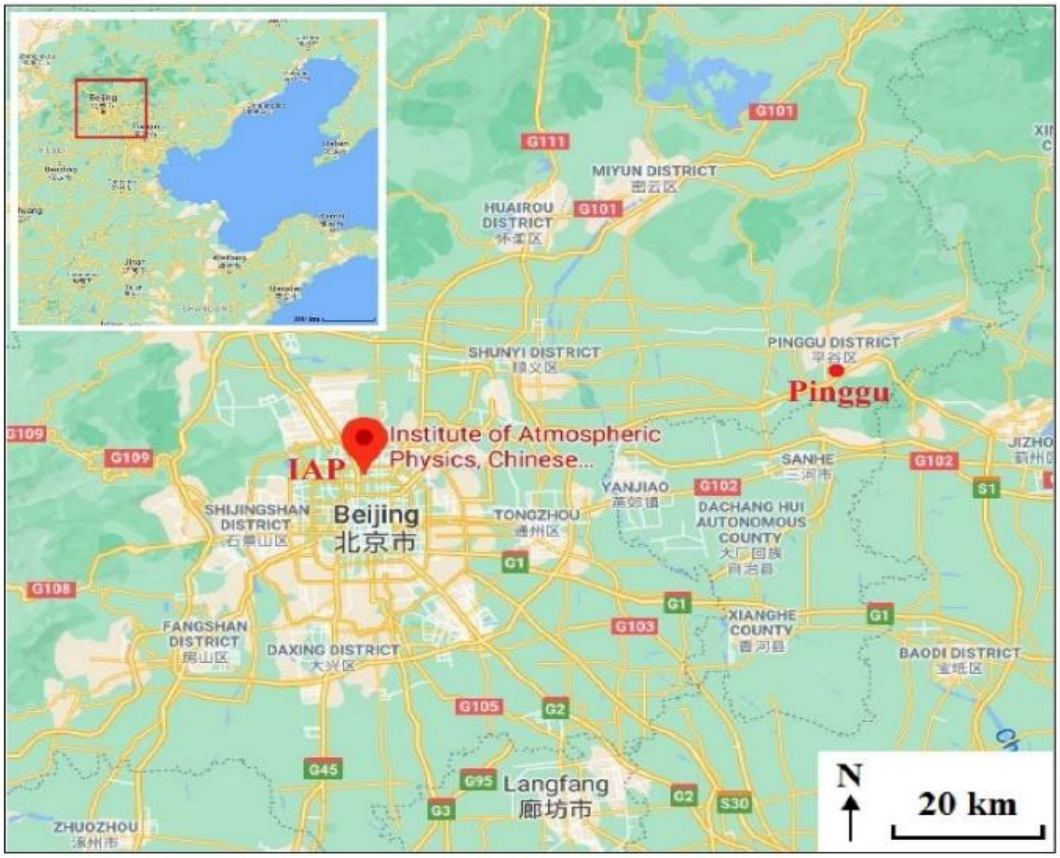

Figure S1: Map of the sampling sites in Beijing (IAP - urban site: Institute of Atmospheric Physics of the Chinese Academy of Sciences; Pinggu - rural site) (source: Xu et al., 2020).

Table S1. Detection limits of the species used in the PMF model.

Species	Detection limit (ng m^{-3})
$PM_{2.5}$	50
OC	30
EC	50
K^+	10
Na^+	32
Ca^{2+}	10.8
NH_4^+	76
NO_3^-	240
SO_4^{2-}	142
Cl^-	138
Ti	3.2
V	4.3
Mn	0.5
Ni	5.2
Zn	2.0
Pb	3.0
Cu	26.4
Fe	43.6
Al	220.6
C26	0.004
C29	0.004
C31	0.004
17α(H)-22,29,30-Trisnorhopane	0.009
17β(H),21α(H)-30-norhopane	0.009
Chrysene	0.008
Benzo(b)fluoranthene	0.008
Benzo(a)pyrene	0.008
Picene	0.009
Coronene	0.008
Levoglucosan	0.0197
Stearic acid	0.004

Table S2. Comparison between modeled and measured species.

Species	Correlation coefficient(r^2)
$PM_{2.5}$	0.90
OC	0.69
EC	0.80
K^+	0.90
Na^+	0.79
Ca^{2+}	0.41
NH_4^+	0.97
NO_3^-	0.92
SO_4^{2-}	0.79
Cl^-	0.98
Ti	0.66
V	0.66
Mn	0.95
Ni	0.78
Zn	0.89
Pb	0.96
Cu	0.54
Fe	0.94
Al	0.71
C26	0.52
C29	0.47
C31	0.65
17α(H)-22,29,30-Trisnorhopane	0.57
17β(H),21α(H)-30-norhopane	0.51
Chrysene	0.56
Benzo(b)fluoranthene	0.63
Benzo(a)pyrene	0.55
Picene	0.55
Coronene	0.63
Levoglucosan	0.77
Stearic acid	0.43

Table S3. Results from bootstrap runs.

	Coal combustion	Road dust	Traffic emissions	Oil combustion	Secondary inorganics	Biomass burning	Soil dust
Coal combustion	98	0	0	0	0	0	0
Road dust	0	98	0	0	0	0	0
Traffic emissions	0	0	98	0	0	0	0
Oil combustion	0	0	1	97	0	0	0
Secondary inorganics	0	0	0	0	98	0	0
Biomass burning	0	0	0	0	0	96	0
Soil dust	0	0	0	0	0	0	98

Table S4. Observed P-value for each factor obtained using t-test.

	Coal combustion	Road dust	Traffic emissions	Oil combustion	Secondary inorganics	Biomass burning	Soil dust
P<0.05	0.17191	0.12272	0.27713	0.10883	0.22586	0.16272	0.07998

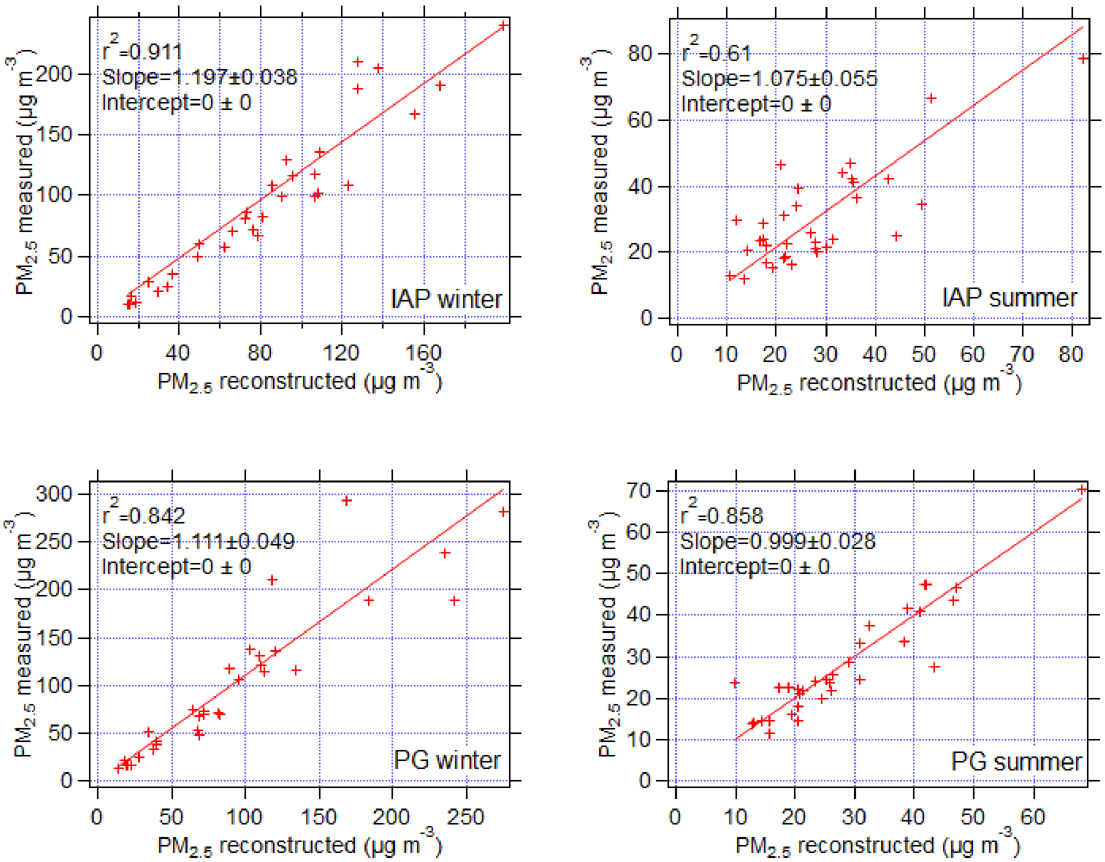

Figure S2. Comparison of reconstructed $PM_{2.5}$ mass using PMF model with $PM_{2.5}$ measurements at both sites, IAP and PG, respectively.

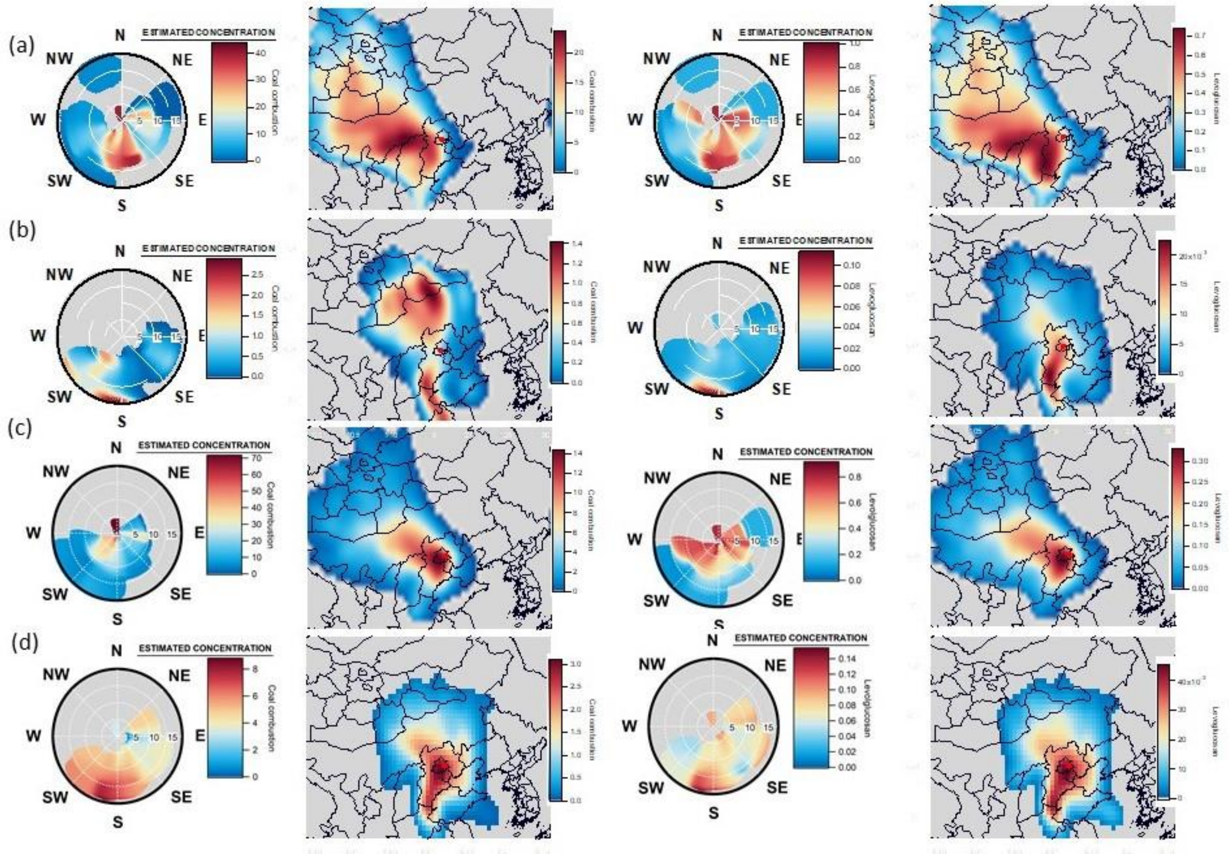

Figure S3. NWR (non parametric wind regression) and CWT (concentrated weighted trajectories results for Coal combustion source and Levoglucosan (a) IAP winter (b) IAP summer (c) PG winter (d) PG summer.

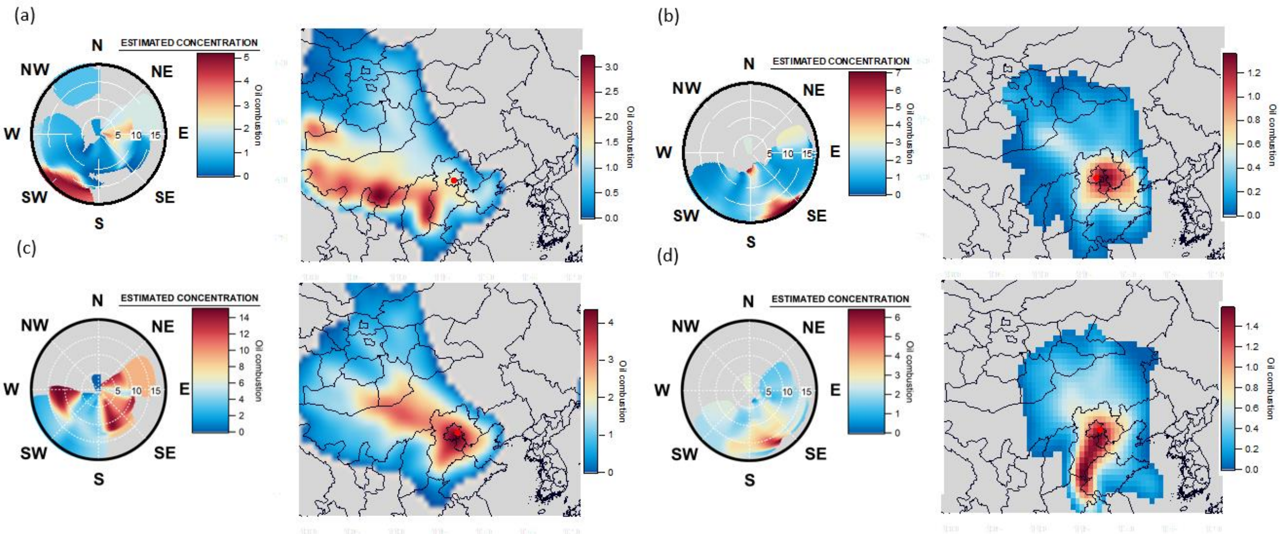

Figure S4. NWR (non parametric wind regression) and CWT (concentrated weighted trajectories results for oil combustion source (a) IAP winter (b) IAP summer (c) PG winter (d) PG summer.

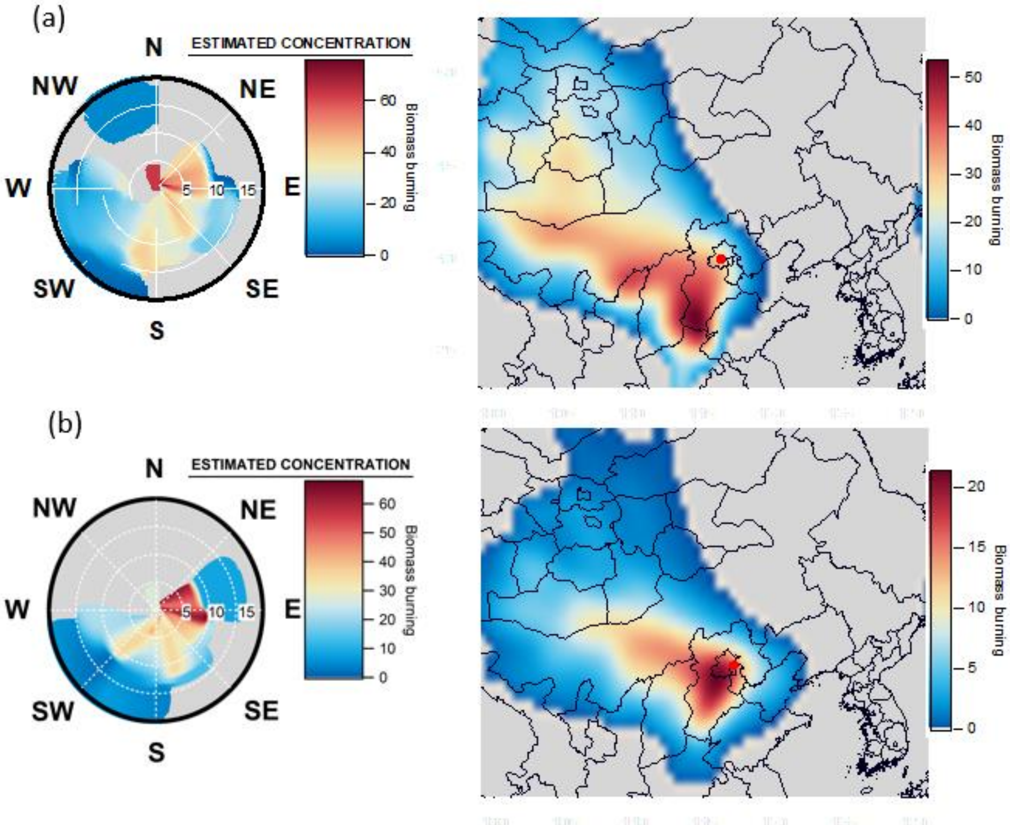

Figure S5. NWR (non parametric wind regression) and CWT (concentrated weighted trajectories results for biomass burning (a) IAP winter (b) PG winter.

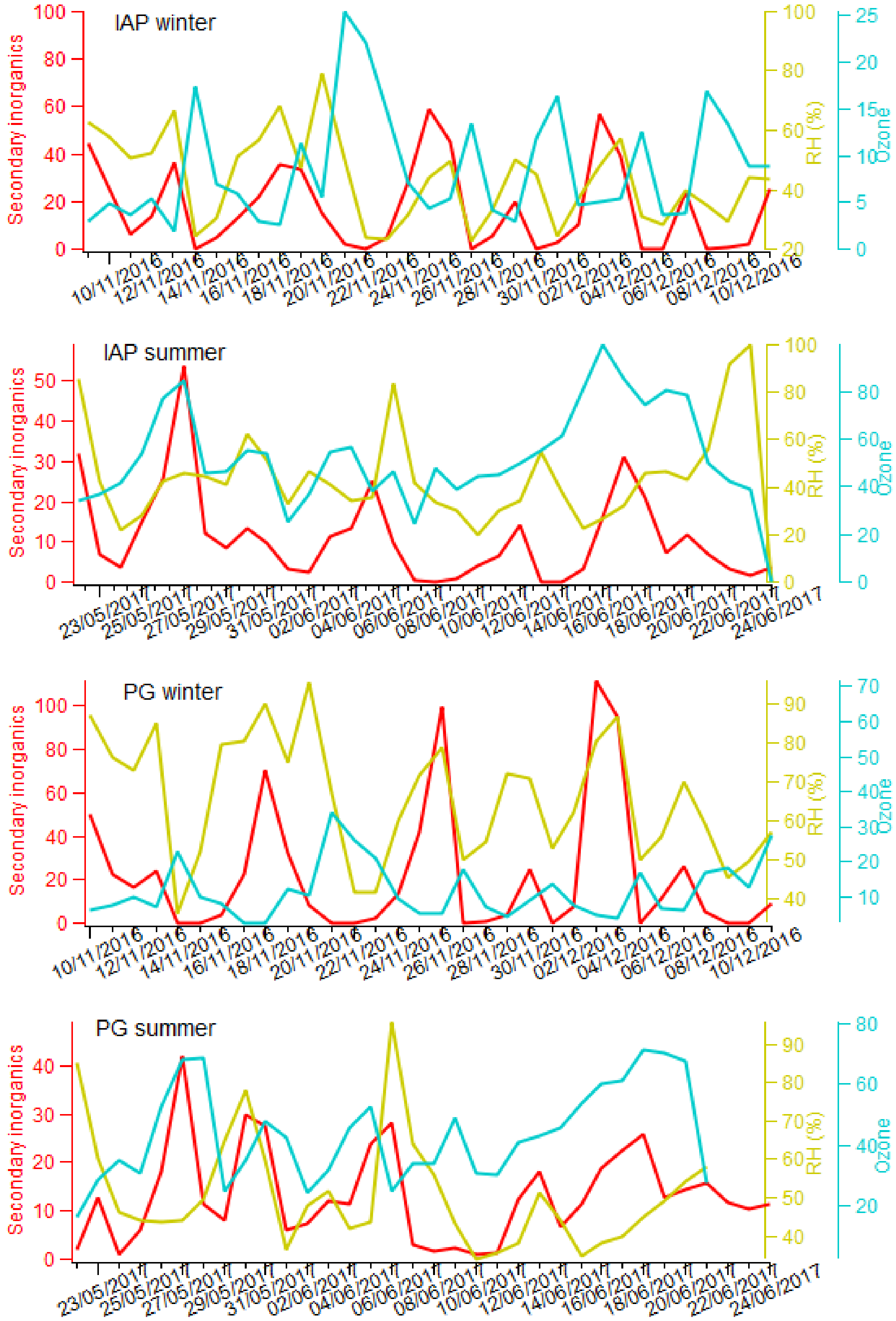

Figure S6. Temporal evolution of the secondary inorganics factor (µg m^{-3}), relative humidity (RH) and ozone (µg m^{-3}).

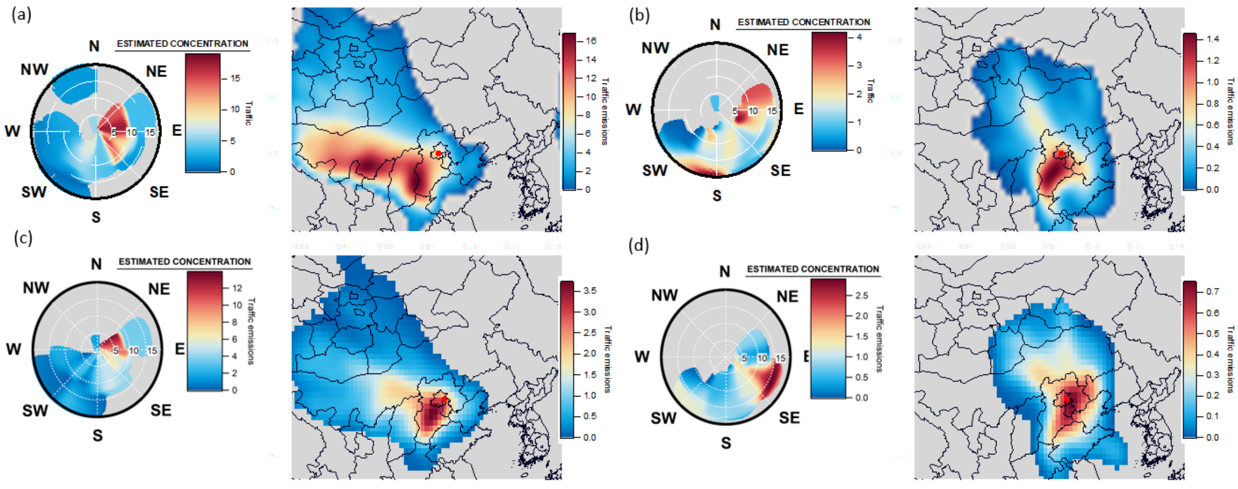

Figure S7. NWR (non parametric wind regression) and CWT (concentrated weighted trajectories results for traffic emissions (a) IAP winter (b) IAP summer (c) PG winter (d) PG summer.

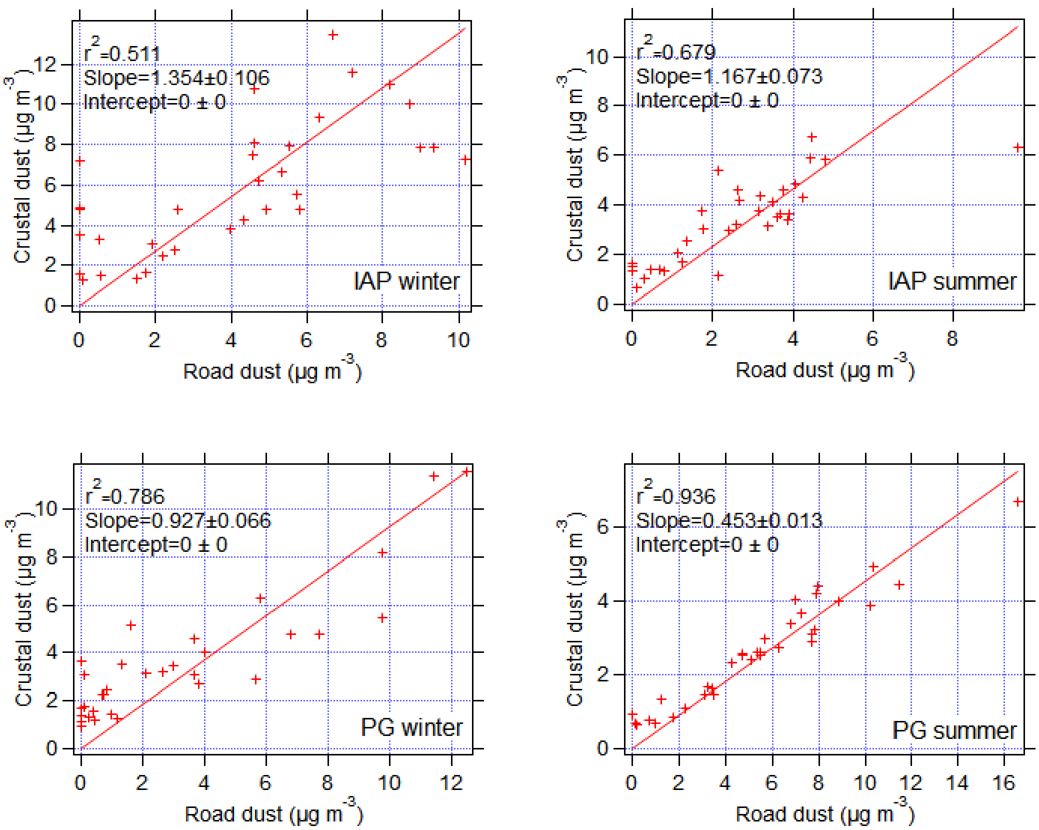

Figure S8. Comparison of estimated Crustal Dust with Road Dust factor resolved at both sites, IAP and PG, respectively.

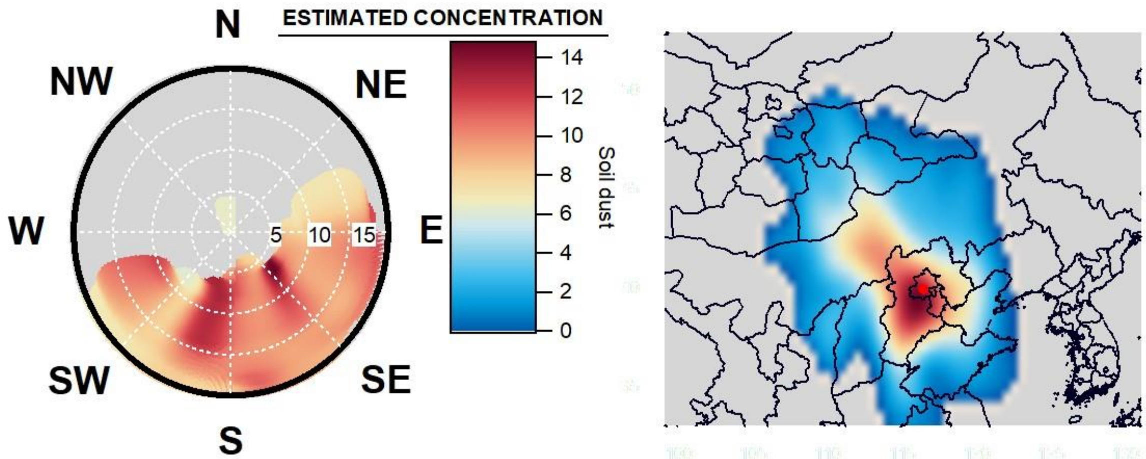

Figure S9. NWR (non parametric wind regression) and CWT (concentrated weighted trajectories results for Soil dust- IAP summer

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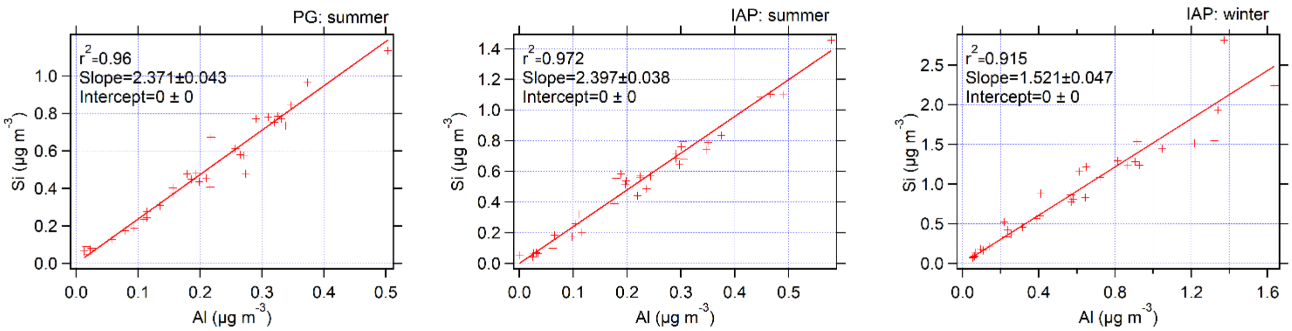

Figure S10. Comparison of Si and Al concentrations at both sites, IAP and PG, respectively.

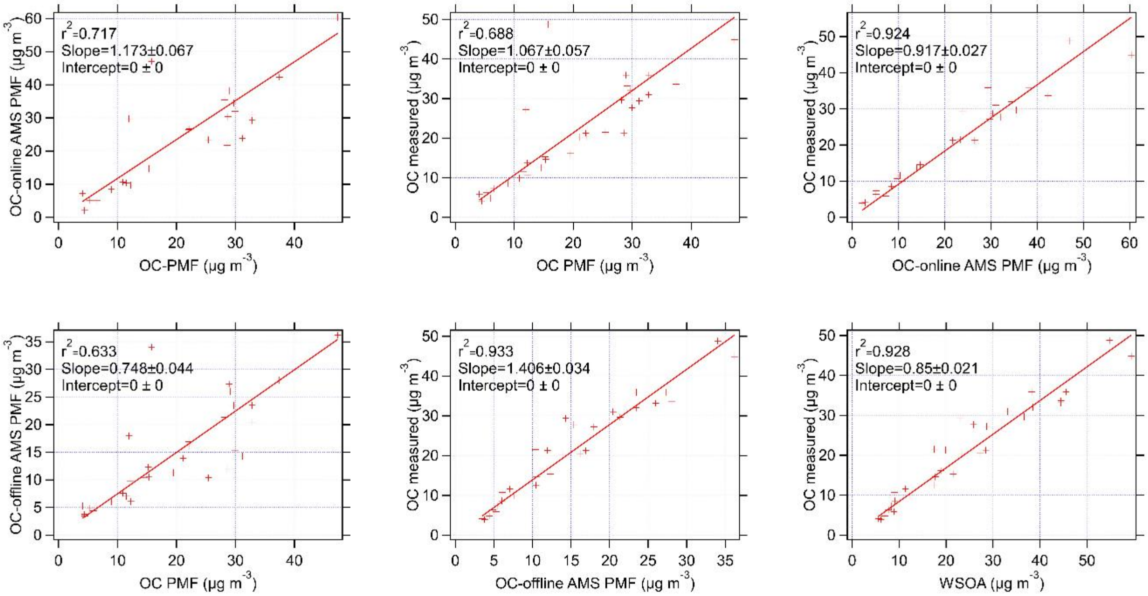

Figure S11. OC mass closure observed at IAP during the winter period: OC modelled by online AMS PMF vs OC model by filter based PMF, OC measured OC model by filter based PMF, OC measured vs OC modelled by online AMS PMF, OC modelled by offline AMS PMF vs OC model by filter based PMF, OC measured vs OC modelled by offline AMS PMF, OC measured vs WSOA.

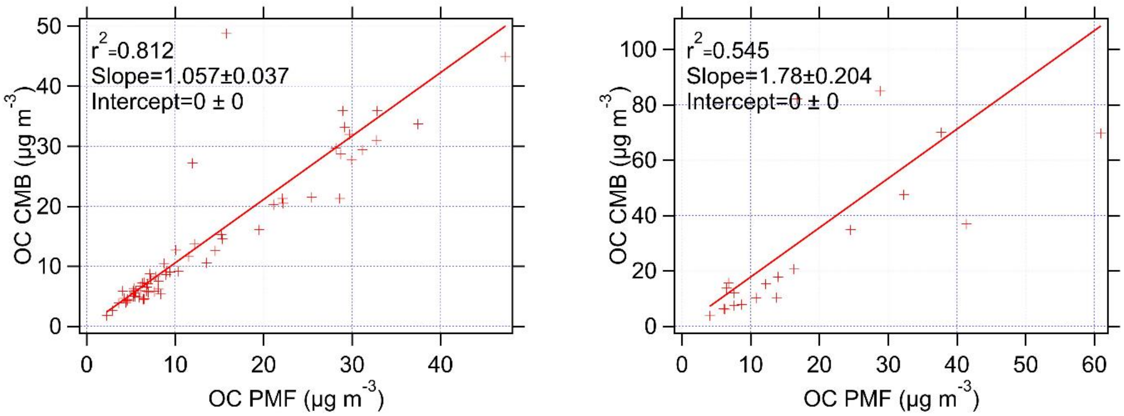

Figure S12. OC mass closure: CMB vs filter-based PMF (right=PG, left =IAP, summer+winter).

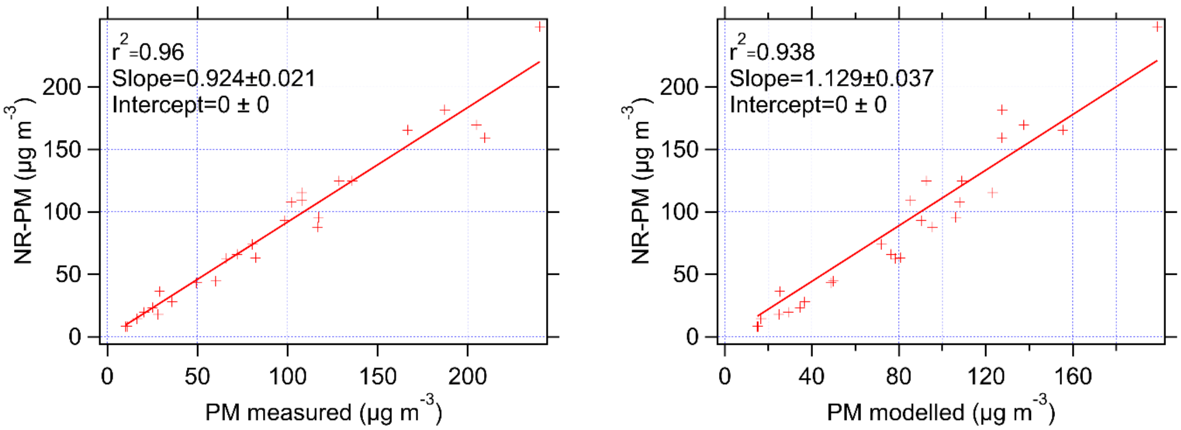

Figure S13. PM mass closure at IAP during the wintertime: NR-PM measured vs PM measured, NR-PM measured vs PM modelled by filter based PMF.

Reference

Xu, J., Liu, D., Wu, X., Vu, T., V.;, Zhang, Y., Fu, P., Sun, Y., Harrison, R., M.;, and Shi, Z.: Source apportionment of fine aerosol at an urban site of Beijing using a chemical mass balance model in preparation, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2020-1020, in review, 2020 .