Supplementary material

Evaluating Atmospheric Pollutants from Urban Buses under Real-World Conditions: Implications of the Main Public Transport Mode in São Paulo, Brazil

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Figure S1. Container utilized at all terminals and placed in the middle of the boarding platform. The inlet for gases and particles where placed at height of 2 m from the ground.

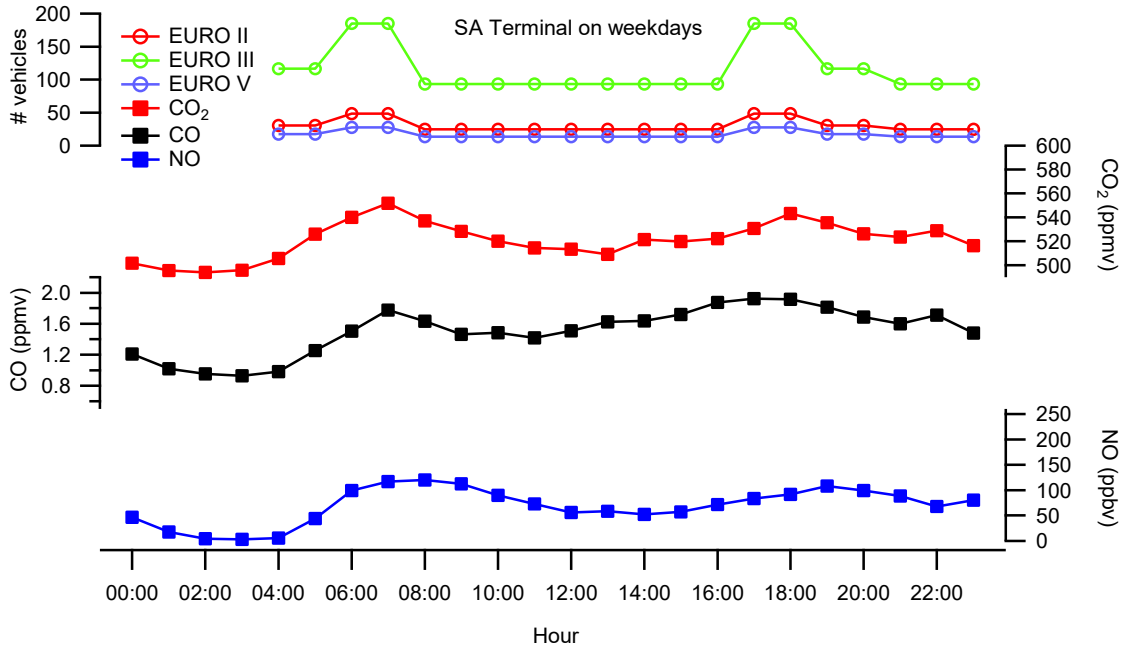

Figure S2. Diurnal profile of CO_2, CO, and NO concentrations and the number of vehicles (by engine type—EURO II, III, and V) circulating at the Santo André (SA) terminal on weekdays.

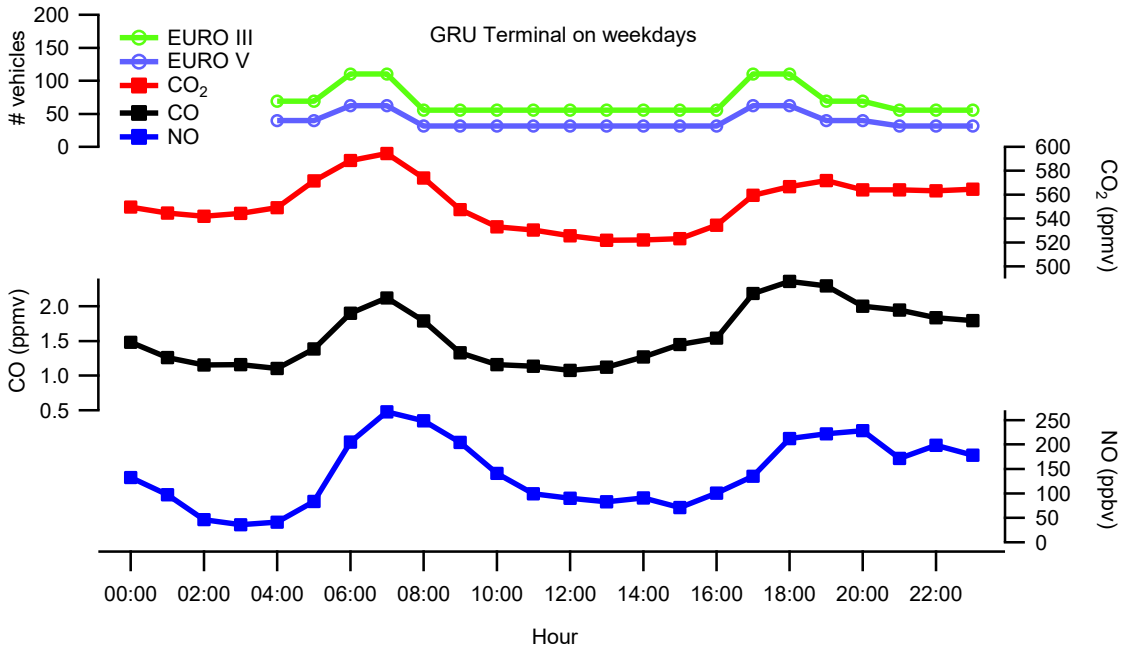

Figure S3. Diurnal profile of CO_2, CO, and NO concentrations and the number of vehicles (by engine type—EURO II, III, and V) circulating at the Guarulhos (GRU) terminal on weekdays.

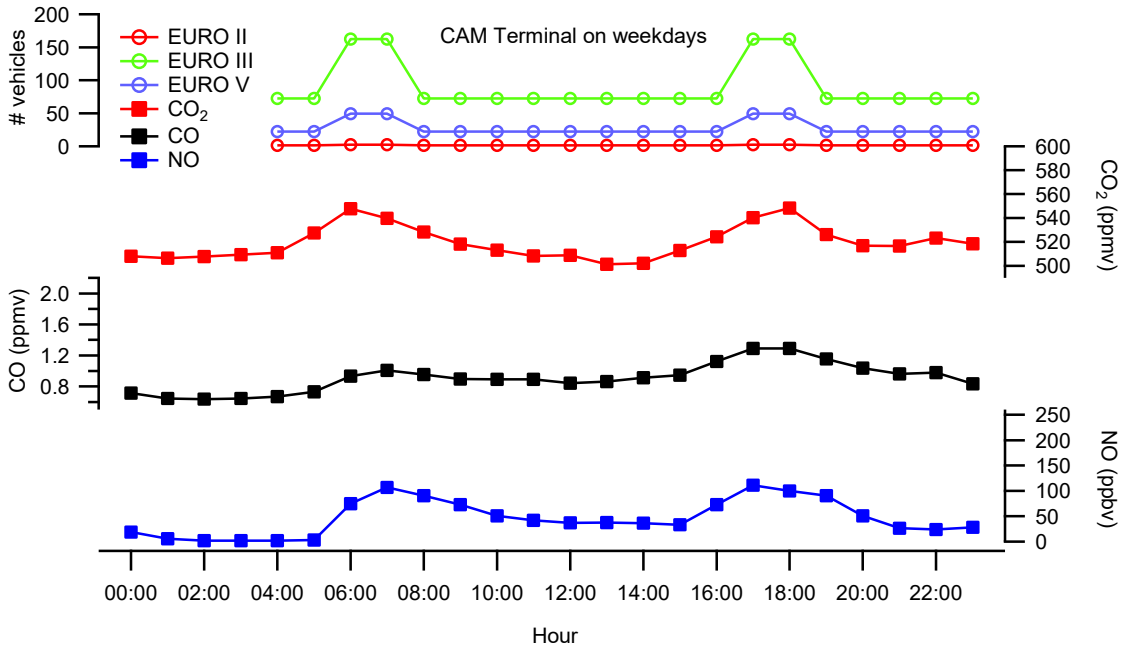

Figure S4. Diurnal profile of CO_2, CO, and NO concentrations and the number of vehicles (by engine type—EURO II, III, and V) circulating at the Campinas (CAM) terminal on weekdays.

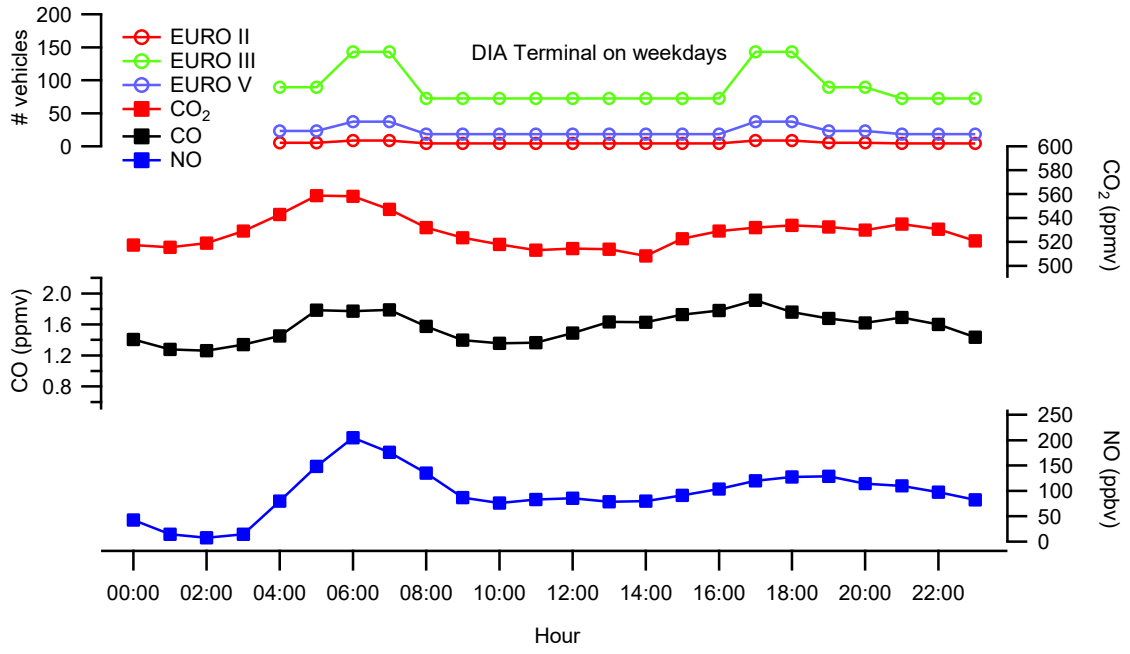

Figure S5. Diurnal profile of CO_2, CO, and NO concentrations and the number of vehicles (by engine type—EURO II, III, and V) circulating at the Diadema (DIA) terminal on weekdays.

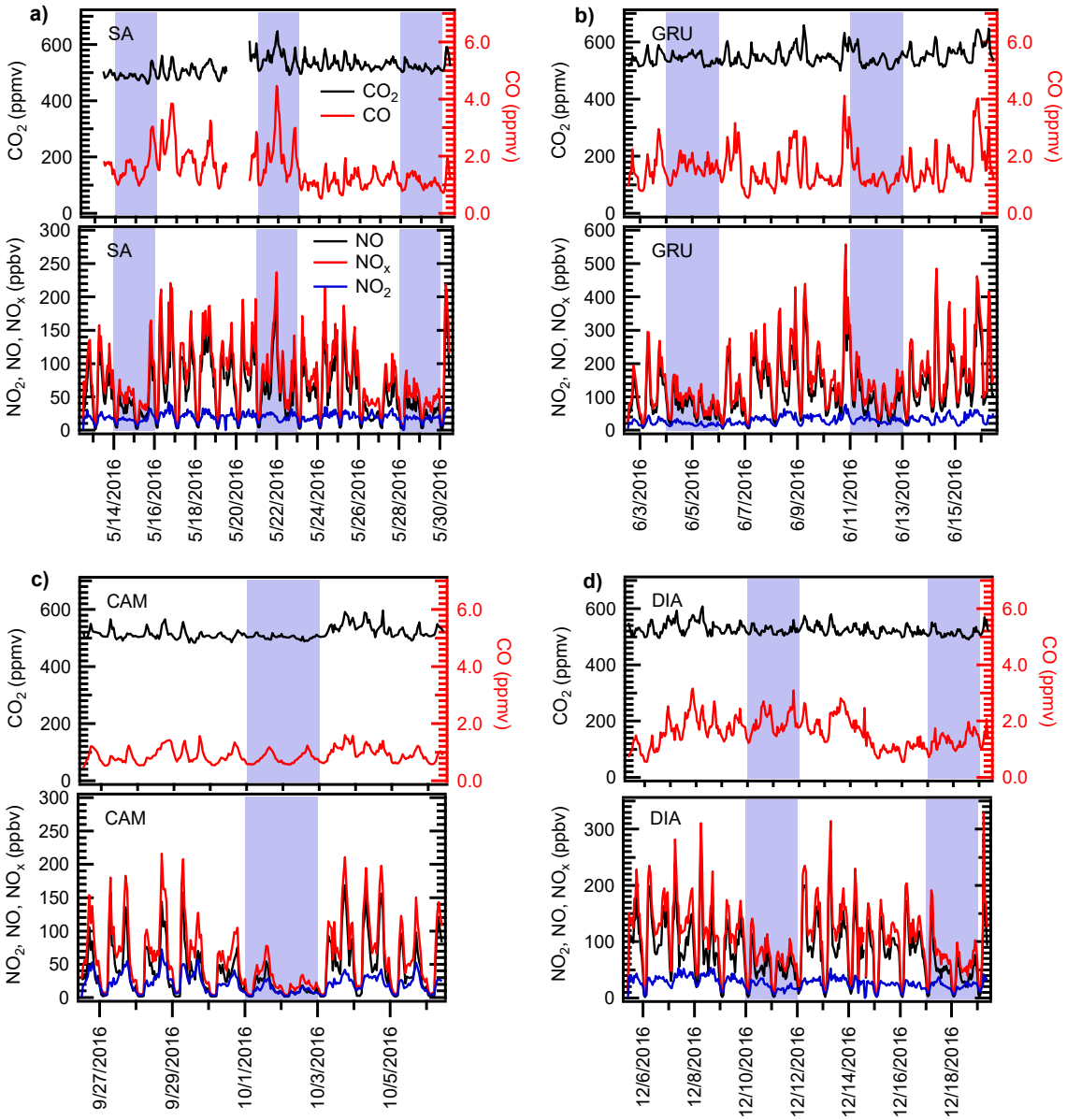

Figure S6. Time series of CO2, CO, NOx, NO, and NO2 concentrations inside the bus terminals under study; (**a**) SA, (**b**) GRU, (**c**) CAM, and (**d**) DIA. Weekends are marked in light blue.

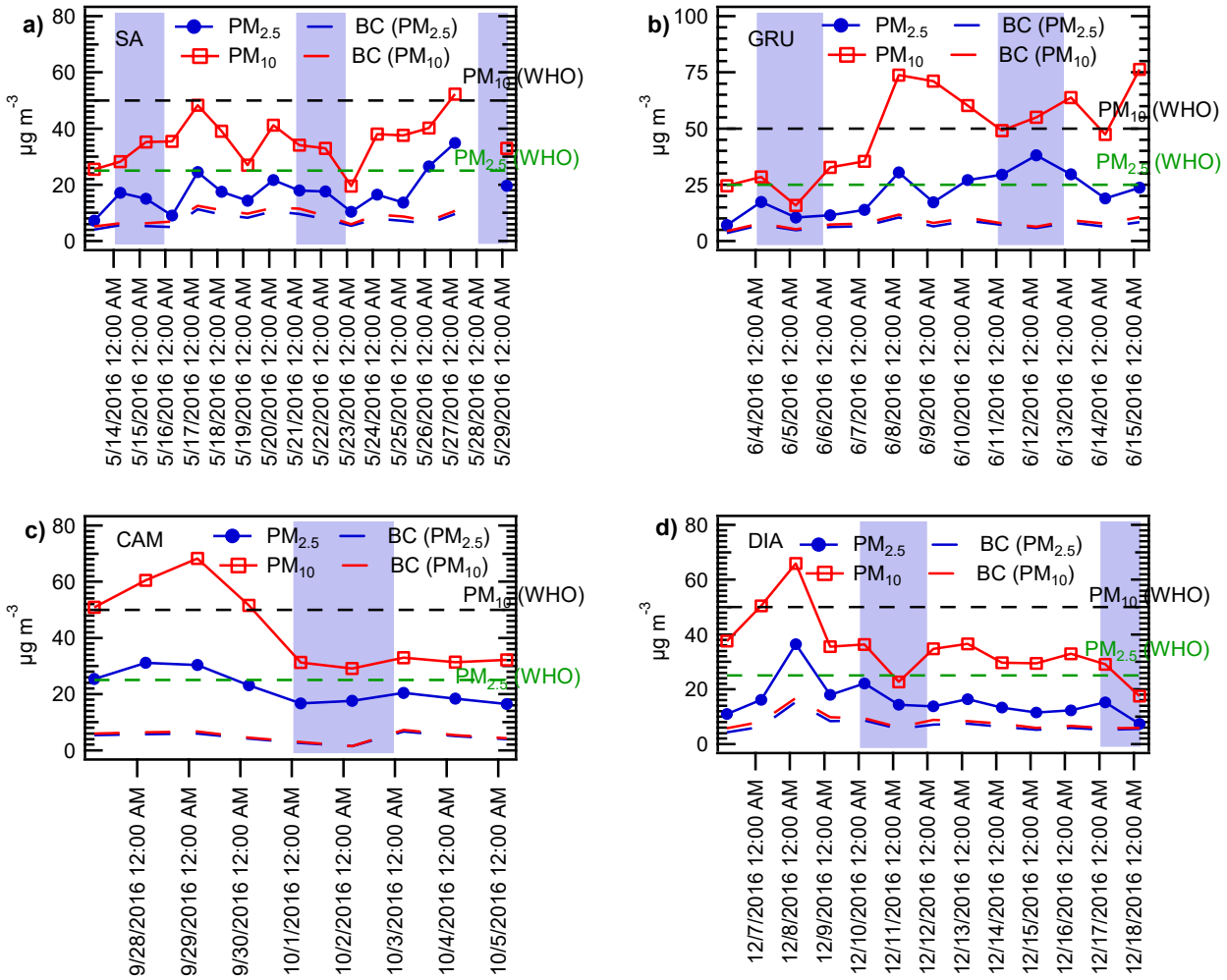

Figure S7. Time series of PM_{10}, $PM_{2.5}$, and BC concentrations inside the bus terminals under study; (**a**) SA (14–29 May 2016), (**b**) GRU (4–15 June 2016), (**c**) CAM (28 September–5 October 2016), and (**d**) DIA (7–18 December 2016). Weekends are marked in light blue.

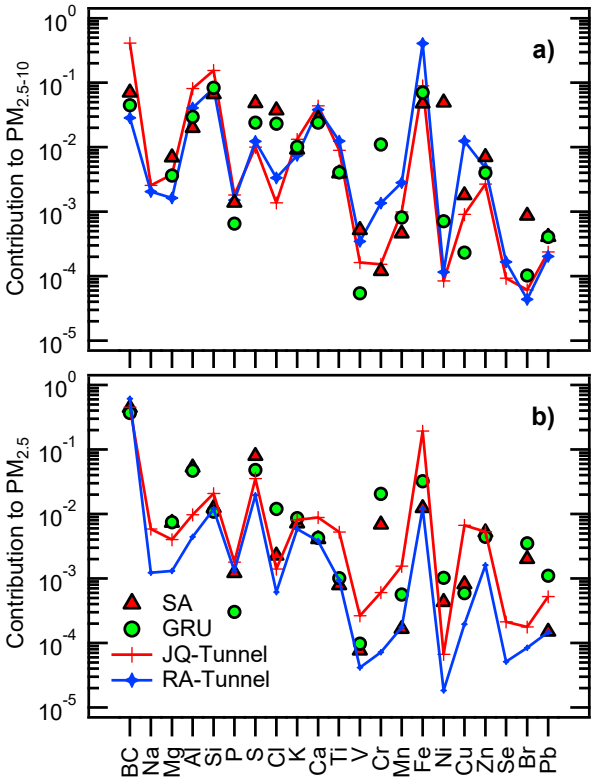

Figure S8. Profile of black carbon (BC) and elemental contributions to (**a**) $PM_{2.5–10}$ and b) $PM_{2.5}$. The symbols represent different sampling sites: the SA bus terminal, the GRU bus terminal, the Jânio Quadros (JQ) tunnel (traveled by LDVs only), and the Rodoanel (RA) tunnel (traveled by LDVs and HDVs).

Table S1 Summary of statistical analysis for PM_{10}, $PM_{2.5}$, and $BC_{2.5}$, at all bus terminal under study in 2016.

Terminal	Pollutant μg m^{-3}	Mean	S.D.	Min	Max	Median	1st quartile	3th quartile	N
SA	PM_{10}	34.6	9.0	19.5	48.3	37.6	26.3	40.2	9
GRU		53.9	19.4	24.5	76.4	60.2	34.1	72.4	9
CAM		46.7	14.8	31.4	67.9	50.8	32.2	60.5	7
DIA		39.2	11.8	29.5	65.9	35.5	31.3	44.0	9
SA	$PM_{2.5}$	15.0	5.7	7.2	24.5	14.3	9.7	19.6	9
GRU		19.9	8.3	7.0	30.4	19.0	12.6	28.2	9
CAM		23.5	5.6	16.5	31.1	23.2	18.4	29.9	7
DIA		16.5	7.8	11.0	36.4	13.8	11.9	17.1	9
SA	$BC_{2.5}$	7.7	2.5	4.0	11.3	7.9	5.2	10.0	9
GRU		7.2	2.0	3.5	10.4	6.7	6.3	8.6	9
CAM		5.3	1.0	4.0	6.7	5.5	4.2	5.9	7
DIA		7.4	3.2	4.3	15.3	6.4	5.6	7.9	9

Table S2. Composition of the $PM_{2.5}$ collected in terminals under study in 2016, as percentage of the total mass.

	SA		GRU		CAM	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
BC	44.5	11.5	37.0	11.0	20.7	7.1
MgO	0.4	0.2	0.5	0.7	0.0	0.0
Al_2O_3	2.7	2.2	2.5	1.0	2.3	0.9
SiO_2	0.6	0.3	0.5	0.2	0.9	0.5
P	0.1	0.1	0.03	0.03	0.05	0.05
$(NH_4)_2SO_4$	7.9	3.5	4.8	1.2	5.8	1.2
Cl	0.2	0.2	1.2	1.1	0.00	0.00
K_2O	0.6	0.4	0.7	0.3	0.7	0.2
$CaCO_3$	0.3	0.1	0.3	0.1	0.3	0.1
TiO	0.0	0.02	0.1	0.02	0.1	0.02
V_2O_5	0.01	0.00	0.01	0.01	0.01	0.00
Cr	0.0	0.0	2.0	2.1	0.0	0.0
MnO_2	0.0	0.0	0.1	0.1	0.01	0.00
Fe_2O_3	0.9	1.6	2.3	4.1	0.1	0.1
NiO	0.00	0.00	0.1	0.1	0.00	0.00
CuO	0.0	0.00	0.1	0.03	0.0	0.00
ZnO	0.4	0.3	0.4	0.2	0.1	0.0
Se	0.00	0.00	0.00	0.00	0.03	0.01
Br	0.2	0.2	0.4	0.1	0.3	0.1
Pb	0.01	0.02	0.1	0.1	0.02	0.01
Total	**59.0**		**53.0**		**31.3**	

Table S3. Composition of the $PM_{2.5-10}$ collected in terminals under study, in 2016, as percentage of the total mass.

	SA		GRU		CAM	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
BC	7.0	2.0	4.5	1.4	2.0	0.8
MgO	0.7	0.4	0.4	0.0	1.5	0.7
Al_2O_3	2.0	1.2	2.9	0.4	2.5	0.7
SiO_2	6.6	0.8	8.3	0.7	8.4	1.4
P	0.1	0.2	0.1	0.1	0.1	0.1
$(NH_4)_2SO_4$	4.8	2.0	2.4	0.6	1.7	0.4
Cl	3.7	4.9	2.3	1.7	0.4	0.4
K_2O	0.9	0.3	1.0	0.1	0.7	0.2
$CaCO_3$	2.7	0.7	2.4	0.3	1.9	0.4
TiO	0.4	0.1	0.4	0.0	0.4	0.0
V_2O_5	0.1	0.1	0.0	0.0	0.0	0.0
Cr	0.0	0.0	1.1	1.8	0.0	0.0
MnO_2	0.0	0.0	0.1	0.1	0.0	0.0
Fe_2O_3	4.7	0.8	7.1	4.6	3.0	0.3
NiO	5.0	11.1	0.1	0.1	0.0	0.0
CuO	0.2	0.3	0.0	0.0	0.0	0.0
ZnO	0.7	0.5	0.4	0.3	0.1	0.0
Se	0.0	0.0	0.0	0.0	0.0	0.0
Br	0.1	0.2	0.0	0.0	0.0	0.0
Pb	0.0	0.1	0.0	0.0	0.0	0.0
Total	**39.9**		**33.5**		**22.7**	

Table S4. Summary of statistical analysis for elemental concentration in $PM_{2.5}$ at all bus terminal under study, in 2016.

Terminal	Element *ng* m^{-3}	Mean	S.D.	Min	Max	Median	1st quartile	3th quartile	N
SA	Mg	32.8	20.1	18.6	47.1	32.8	18.6	47.1	2
GRU		37.0	43.2	5.7	100.9	20.7	9.0	81.2	4
CAM									1
SA	Al	560.2	197.6	433.8	788.0	458.9	433.8	788.0	3
GRU		452.3	144.9	311.7	709.8	394.3	335.2	581.9	9
CAM		438.0	102.2	303.9	594.5	414.0	359.6	547.2	7
SA	Si	61.6	27.2	31.1	109.5	50.5	43.8	87.2	8
GRU		102.3	66.2	36.4	226.1	104.9	38.8	150.4	9
CAM		186.0	133.1	36.4	385.6	135.9	44.6	284.9	7
SA	P	16.3	7.5	10.2	29.9	14.2	10.8	21.3	6
GRU		4.0	3.7	0.6	7.9	3.4	0.6	7.9	3
CAM		9.4	5.7	5.9	19.3	6.3	6.0	14.2	5
SA	S	1110.4	790.2	300.8	2298.1	787.4	380.2	1863.2	9
GRU		930.8	547.1	197.8	1770.2	876.8	517.2	1483.9	9
CAM		1296.9	329.7	861.8	1773.7	1369.7	928.8	1545.6	7
SA	Cl	25.9	20.9	0.1	59.3	24.0	7.1	44.6	9
GRU		297.5	353.4	8.1	1043.2	216.1	12.8	486.3	8
CAM									1
SA	K	51.0	24.9	13.6	84.7	47.9	30.3	77.8	9
GRU		144.3	93.4	22.0	283.3	179.1	50.9	212.7	9

CAM		175.9	86.6	56.1	292.3	138.4	130.8	280.4	7
SA	Ca	46.9	29.1	18.5	105.7	34.6	24.7	66.3	9
GRU		57.1	21.6	26.5	89.2	62.5	36.4	73.0	9
CAM		72.9	37.6	28.8	138.9	65.6	40.8	102.0	7
SA	Ti	5.9	2.7	3.5	11.6	5.0	3.8	7.6	9
GRU		11.3	5.8	2.3	20.1	10.7	6.7	16.6	9
CAM		15.3	6.5	8.3	25.6	14.1	9.1	20.7	7
SA	V	1.3	1.1	0.2	3.7	0.8	0.4	2.0	9
GRU		1.6	1.6	0.4	4.7	0.9	0.7	2.8	6
CAM		1.9	0.8	0.8	3.0	1.8	1.2	2.6	5
SA	Cr								1
GRU		299.5	387.7	36.4	744.7	117.3	36.4	744.7	3
CAM									1
SA	Mn	3.0	3.5	0.6	10.4	1.2	0.9	4.3	7
GRU		10.5	16.7	2.8	48.2	4.4	2.9	6.5	7
CAM		1.8	1.3	1.1	3.7	1.2	1.1	3.1	4
SA	Fe	216.1	275.4	3.8	527.2	117.2	3.8	527.2	3
GRU		478.8	767.4	60.1	2184.9	136.0	68.8	438.2	7
CAM		22.1	16.4	6.3	39.1	21.0	6.3	39.1	3
SA	Ni								1
GRU		15.2	23.3	1.8	50.0	4.6	1.9	39.3	4
CAM									1
SA	Cu								1
GRU		15.2	23.3	1.8	50.0	4.6	1.9	39.3	4
CAM									1

SA	Zn	45.4	37.5	4.7	125.2	38.0	17.8	68.1	9
GRU		89.9	65.8	8.9	183.3	97.2	26.6	145.9	9
CAM		20.3	3.0	16.9	24.0	19.3	17.1	23.4	7
SA	Se								1
GRU									1
CAM		6.5	1.8	3.8	9.5	6.6	5.3	7.3	7
SA	Br	26.9	35.3	0.9	85.4	5.3	2.8	67.5	9
GRU		64.3	10.4	40.9	76.0	66.9	59.4	72.2	9
CAM		68.2	3.5	64.5	72.8	67.8	64.9	71.6	7
SA	Pb	2.1	2.1	0.2	5.1	1.2	0.6	5.0	7
GRU		24.7	24.4	1.1	80.0	19.2	5.4	34.8	9
CAM		3.7	3.1	1.5	5.9	3.7	1.5	5.9	2