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Atmospheric Chemistry and Physics Discussions

Supplement of

Advantages of city-scale emission inventory for urban air quality research and policy: the case of Nanjing, a typical industrial city in the Yangtze River Delta, China

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Tables

Table S1. Technology distribution by vehicle type (share of each technology level out of each vehicle type) in Nanjing, for the year 2012.

Vehicle type		Pre-stage Ⅰ	Stage Ⅰ	Stage Ⅱ	Stage Ⅲ	Stage Ⅳ
Passenger vehicle	Mini bus	13.39%	54.44%	6.65%	14.63%	10.89%
	Light-duty	1.61%	8.91%	17.97%	37.43%	34.08%
	Medium-duty	28.11%	18.94%	32.40%	16.90%	3.65%
	Heavy-duty	6.37%	14.45%	26.27%	42.98%	9.94%
Truck	Mini truck	2.86%	0.00%	57.14%	40.00%	0.00%
	Light-duty	2.33%	22.01%	11.64%	46.24%	17.79%
	Medium-duty	15.84%	33.66%	16.87%	28.26%	5.37%
	Heavy-duty	2.57%	12.15%	14.48%	56.39%	14.41%
Motorcycle		14.62%	18.43%	44.69%	22.26%	0.00%
Taxi		0.06%	0.00%	1.00%	44.49%	54.45%
Bus	Medium-duty	0.00%	1.67%	23.96%	59.61%	14.76%
	Heavy-duty	0.70%	4.36%	35.68%	57.15%	2.11%
Sum		5.16%	12.46%	23.68%	34.10%	24.60%

Table S2. Annual average vehicle kilometers traveled (VKT), average age and average accumulated mileage of the fleet in Nanjing, for the year 2012.

	Annual average VKT (km)	Average age (year)	Average accumulated mileage (km)
Minibus	25574	3.86	98716
Light-duty passenger vehicle	25574	3.86	98716
Medium-duty passenger vehicle	66400	6.73	446872
Heavy-duty passenger vehicle	66400	6.73	446872
Mini truck	44000	4.4	193600
Light-duty truck	44000	4.4	193600
Medium-duty truck	63300	7.23	457659
Heavy-duty truck	105600	3.93	415008
Motorcycle	7303	6.42	46885
Taxi	138000	2.18	300840
Bus	43940	4.51	198169

Table S3. The emission factors for typical industrial processes. Note the numbers for $PM_{2.5}$, $PM_{2.5-10}$, and $PM_{>10}$ are unabated emission factors. The numbers for BC and OC are the mass fractions of corresponding carbonaceous aerosol species to $PM_{2.5}$ (dimensionless), and the units for other species are kg/t-product unless specifically noted.

Sector	Process/source	SO_2	NO_X	$PM_{2.5}$	$PM_{2.5-10}$	$PM_{>10}$	BC	OC	VOCs	CO	CO_2	NH_3
Iron & steel production	Machinery coking	1.35[a]	1.70[b]	1.3[c]	0.8[c]	2.9[c]	0.40[c]	0.35[c]	2.40[d]	0.10[e]		
	Sintering	2.82[g]	0.64[g]	3.29[c]	3.76[c]	39.95[c]	0.01[c]	0.05[c]	0.25[g]	11[h]	2067[f]	
	Pig iron	0.11[i]/0.10[i]	0.17[g]	7.32[c]	5.86[c]	35.6[c]	0.19[c]	0.04[c]		4.20[e]		
	Steel			17.6[c]/5.4[c]	5.2[c]/1.6[c]	17.2[c]/5.2[c]		0.2[c]/0.02[c]	0.06[g]	22[e]/9[h]		
Non-ferrous metal smelting	Aluminum	6[i]		17.1[c]	8.6[c]	19.4[c]						
	Lead	80[c]		205[c]	25[c]	20[c]						
	Copper	212[c]		211[c]	25.8[c]	20.6[c]					520[f]	
	Zinc	80[c]		161[c]	19.6[c]	15.7[c]					1720[f]	
Other industrial production	Brick	0.53[i]	0.13[i]	0.27[c]	0.44[c]	2.99[c]	0.40[c]	0.35[c]	0.20[d]	150[h]	1731[f]	
	Lime	1.0[c]	1.6[c]	1.8[c]	9[c]	79.2[c]	0.02[c]	0.04[c]		115[h]	750[f]/1731[f]	
	Glass			9.65[c]	0.42[c]	0.53[c]			4.4[d]		200[f]	
	Sulfuric acid	3.4[c]										
	Nitric acid		7.1[c]									
	Ammonia	3.0[c]	0.9[c]						4.7[d]	142[h]	4582[f] / 3273[f] /2104[f]	1.05[c]
	Refinery	0.9[c]	0.3[c]	0.10[c]	0.02[c]				-	10[h]		

[a] He (2006)

[b] Huo et al. (2012)

[c] Zhao et al. (2013). Numbers for steel production indicate emission factors for basic oxygen furnace/electric arc furnace, respectively.

[d] Wei (2009)

[e] From Onsite investigations in Nanjing.

[f] Zhao et al. (2012a). Numbers for ammonia production indicate emission factors for processes using coal/oil/gas as energy, respectively. Numbers for lime production indicate emission factors for calcinations of carbonates (kg/t-lime) and combustion processes (kg/t-coal), respectively. The unit is kg/t-coal for brick production.

[g] Lei (2008).

[h] Zhao et al. (2012b). The unit is kg/t-coal for brick and lime production.

[i] MEP (2010). Numbers for SO_2 from pig iron production indicate emission factors for blast furnaces with gas volume over 2000 m^3/350-2000 m^3, respectively.

Table S4. The emissions (estimated by this work) and ambient concentrations (Yu et al., 2014) of SO_2, NO_X/NO_2, $PM_{2.5}$, PM_{10} and CO for August 16-24, 2012 and August 16-24, 2013 (the period of Youth Asian Games, 2013) in Nanjing.

		SO_2	NO_X/NO_2	$PM_{2.5}$	PM_{10}	CO
Emissions (metric tons)	Aug 16-24, 2012	3387	5073	1814	2365	21087
	Aug 16-24, 2013	2608	3501	1433	2034	14128
	Reduction rate	23%	31%	21%	14%	33%
Concentrations (ug/m^3)	Aug 16-24, 2012	27	41	43	89	896
	Aug 16-24, 2013	21	30	38	73	699
	Reduction rate	22%	27%	18%	12%	22%

Figures

Figure S1.

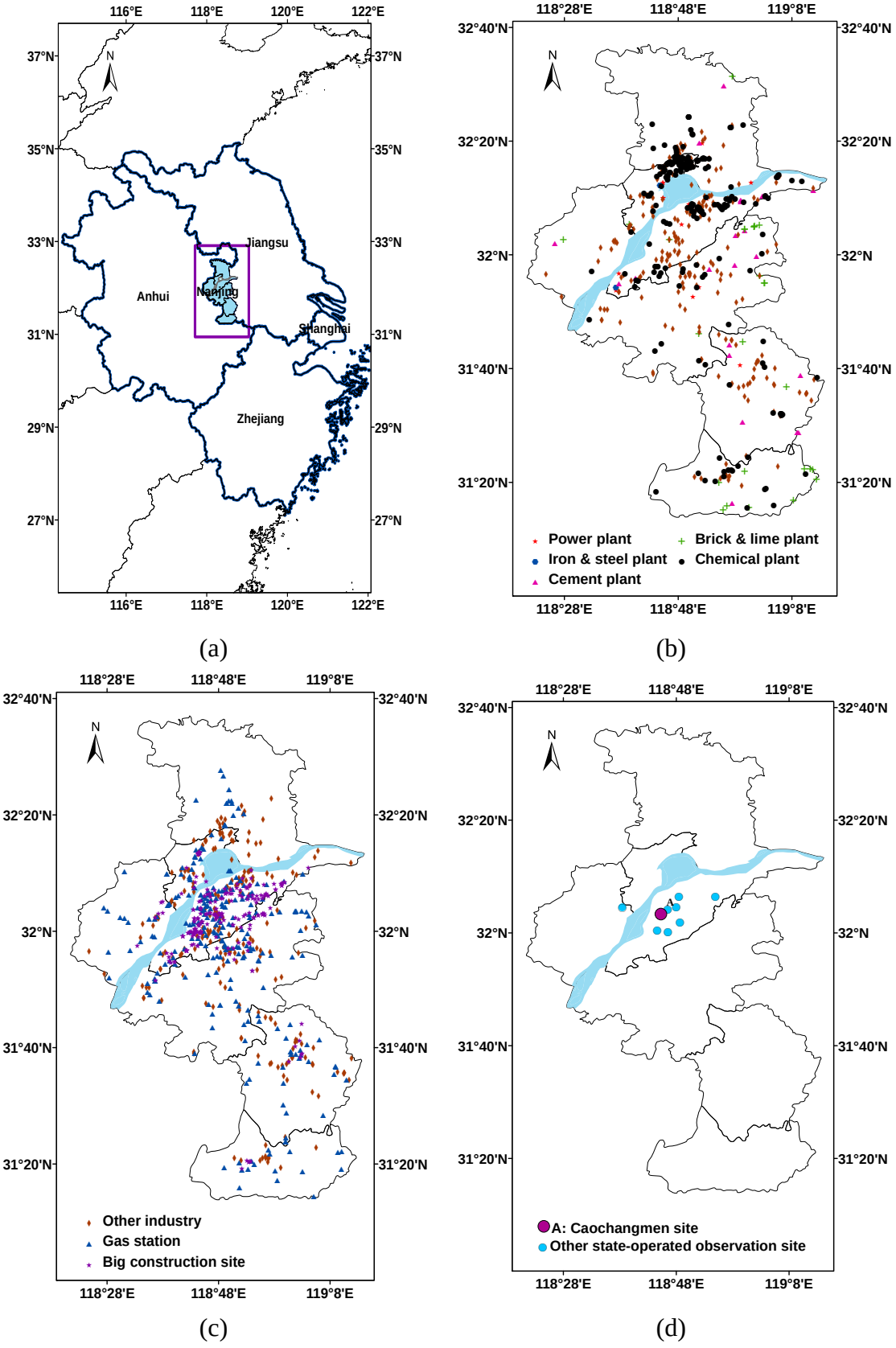


Figure S2.

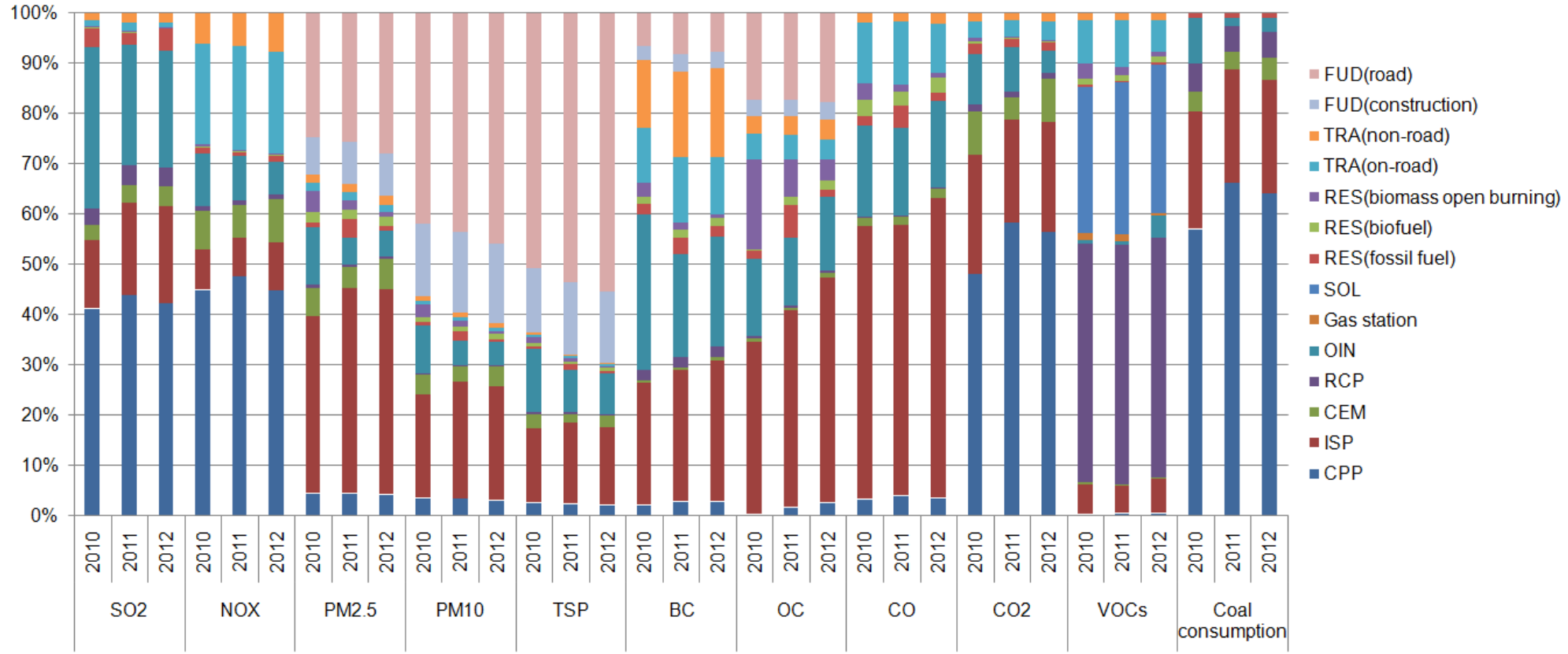

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2010
2011
2012
SO2
NOX
PM2.5
PM10
TSP
BC
OC
CO
CO2
VOCs
Coal consumption
FUD(road)
FUD(construction)
TRA(non-road)
TRA(on-road)
RES(biomass open burning)
RES(biofuel)
RES(fossil fuel)
SOL
Gas station
OIN
RCP
CEM
ISP
CPP

Figure S3.

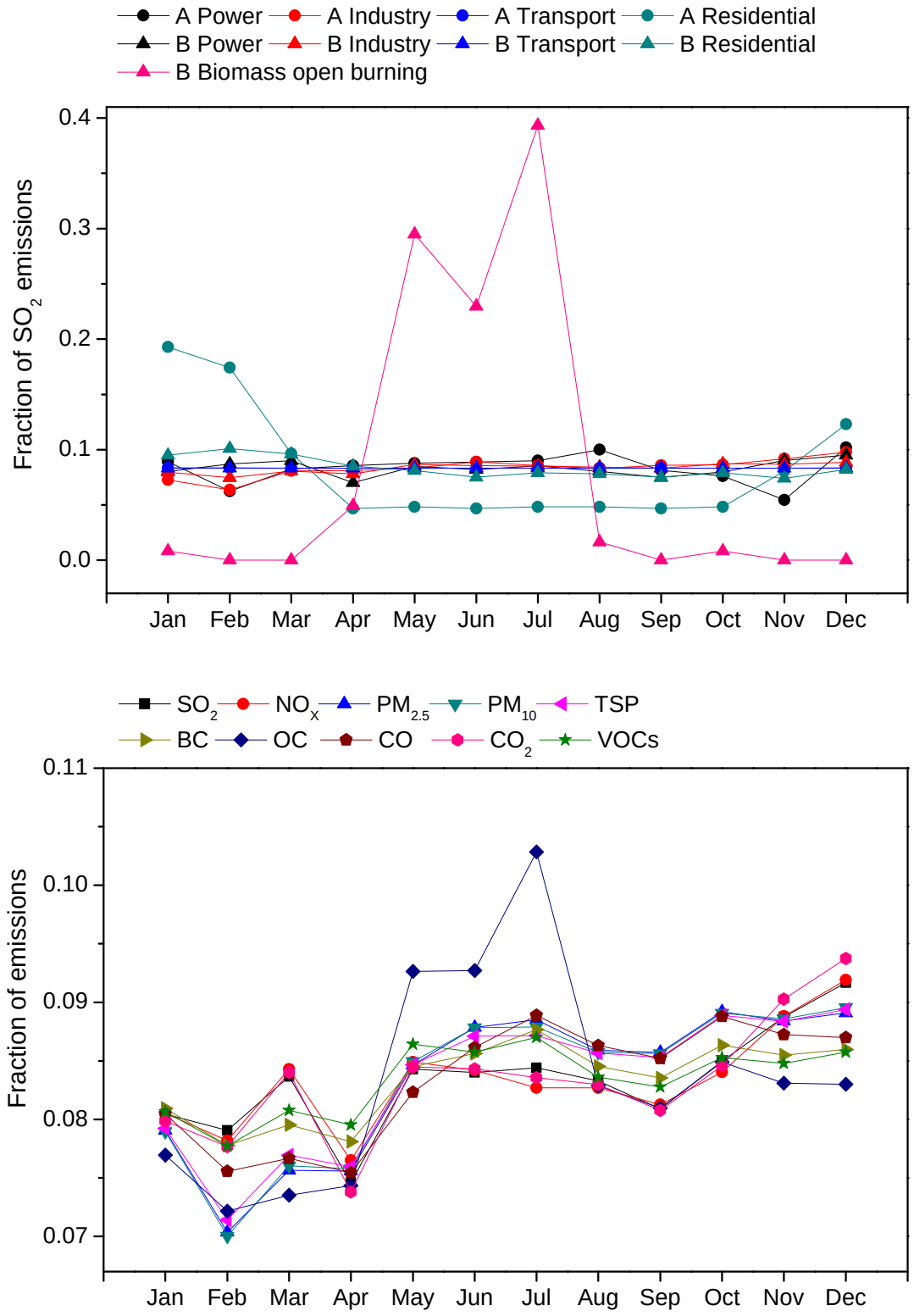

A Power
A Industry
A Transport
A Residential
B Power
B Industry
B Transport
B Residential
B Biomass open burning
Fraction of SO2 emissions
0.4
0.3
0.2
0.1
0.0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
SO2
NOX
PM2.5
PM10
TSP
BC
OC
CO
CO2
VOCs
Fraction of emissions
0.11
0.10
0.09
0.08
0.07

Figure S4.

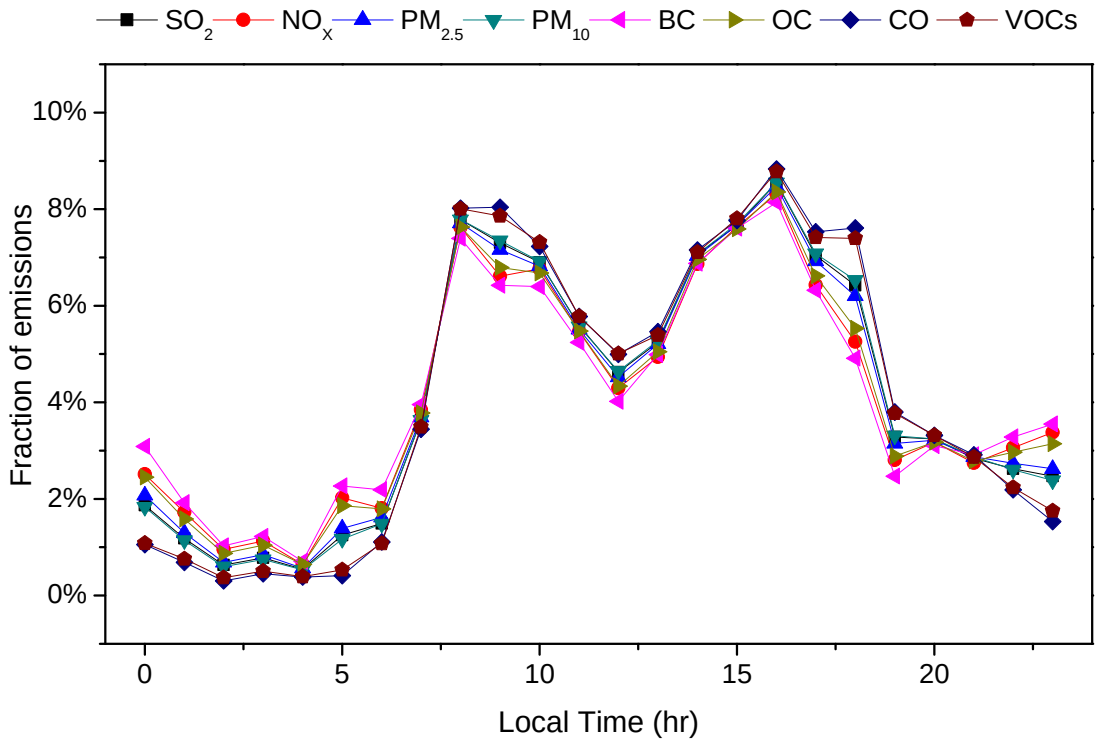

SO2
NOX
PM2.5
PM10
BC
OC
CO
VOCs
Fraction of emissions
10%
8%
6%
4%
2%
0%
0
5
10
15
20
Local Time (hr)

Figure S5.

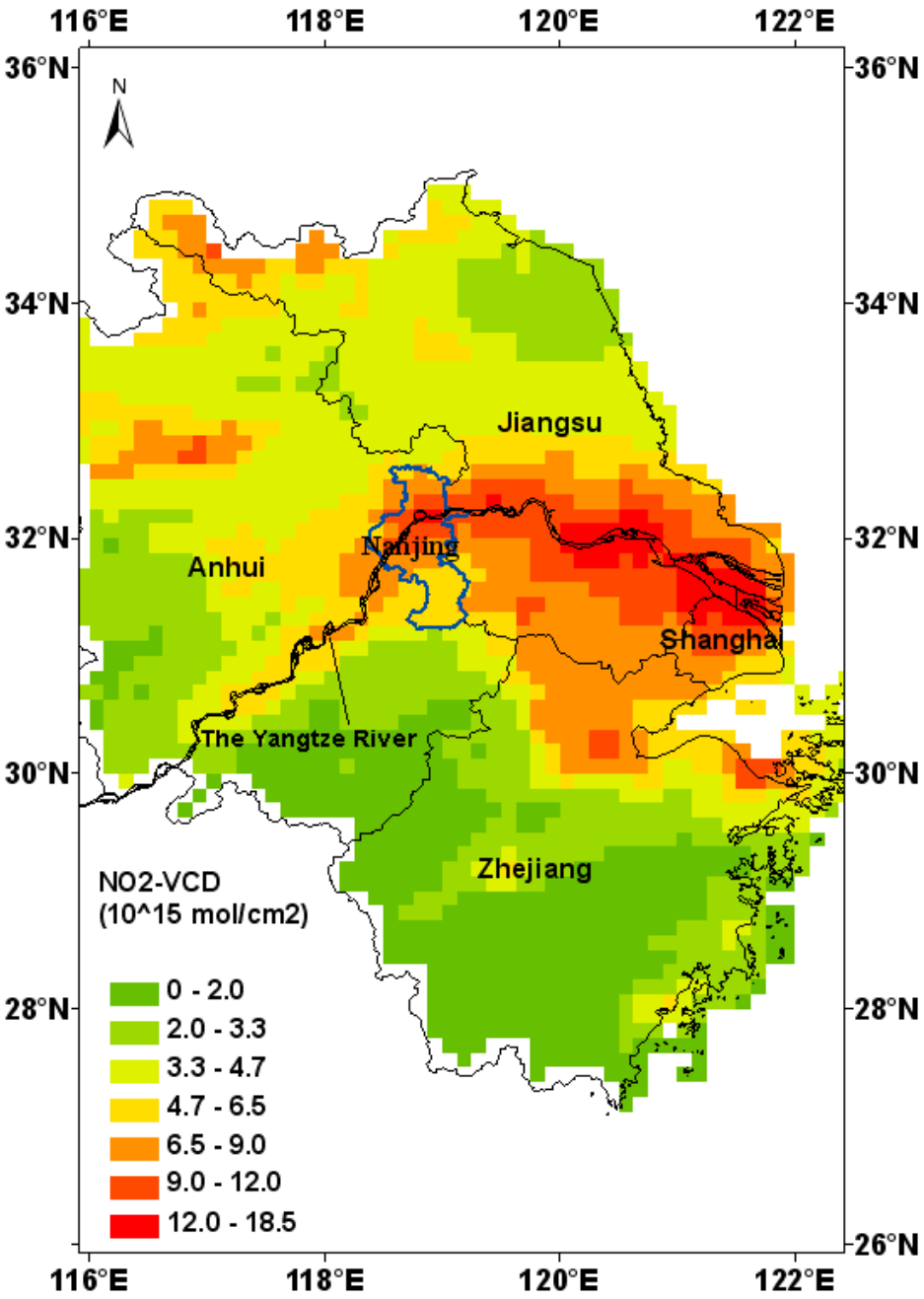

116°E
118°E
120°E
122°E
36°N
34°N
32°N
30°N
28°N
26°N
N
Jiangsu
Anhui
Nanjing
Shanghai
The Yangtze River
Zhejiang
NO2-VCD
(10^15 mol/cm2)
0 - 2.0
2.0 - 3.3
3.3 - 4.7
4.7 - 6.5
6.5 - 9.0
9.0 - 12.0
12.0 - 18.5

Figure S6.

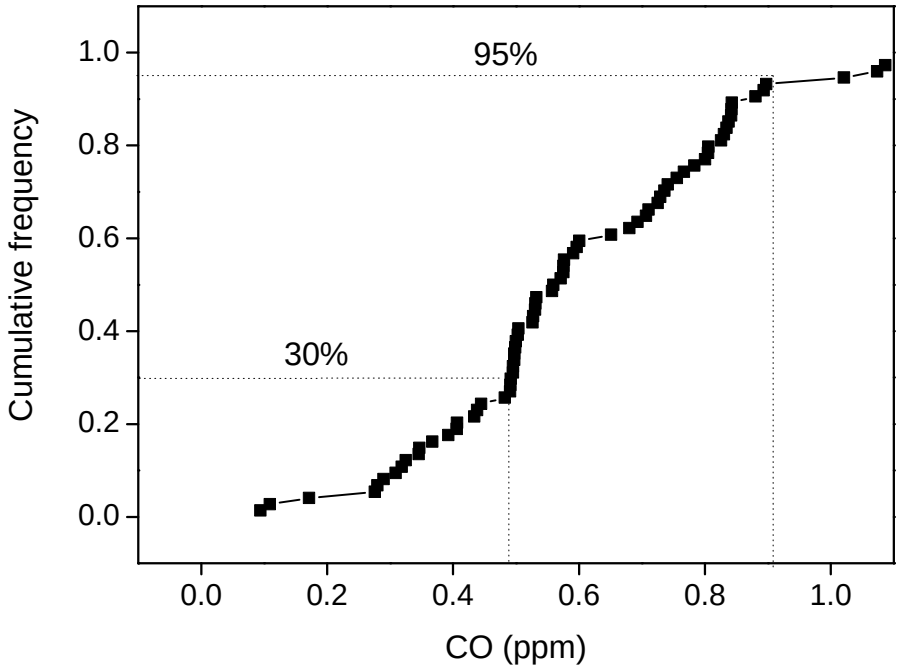

Cumulative frequency
1.0
0.8
0.6
0.4
0.2
0.0
95%
30%
0.0
0.2
0.4
0.6
0.8
1.0
CO (ppm)

Figure S7.

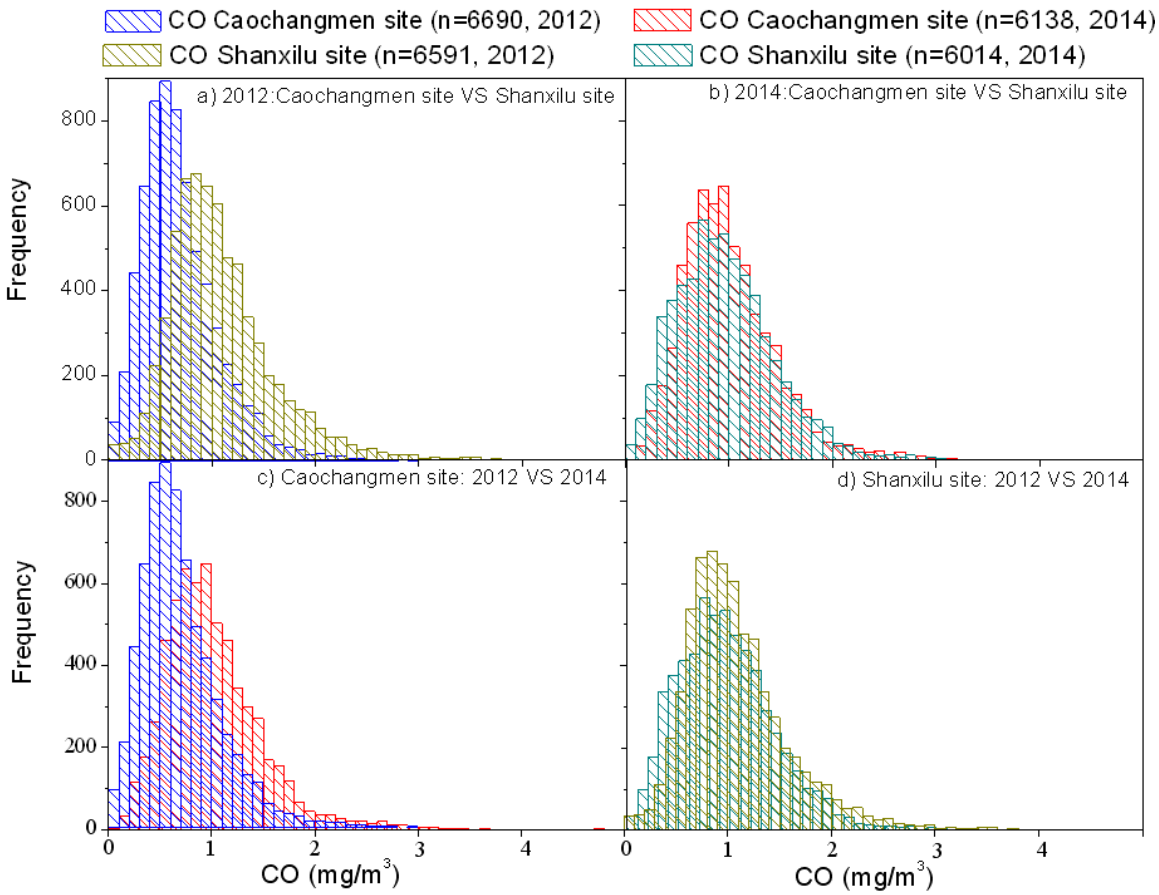
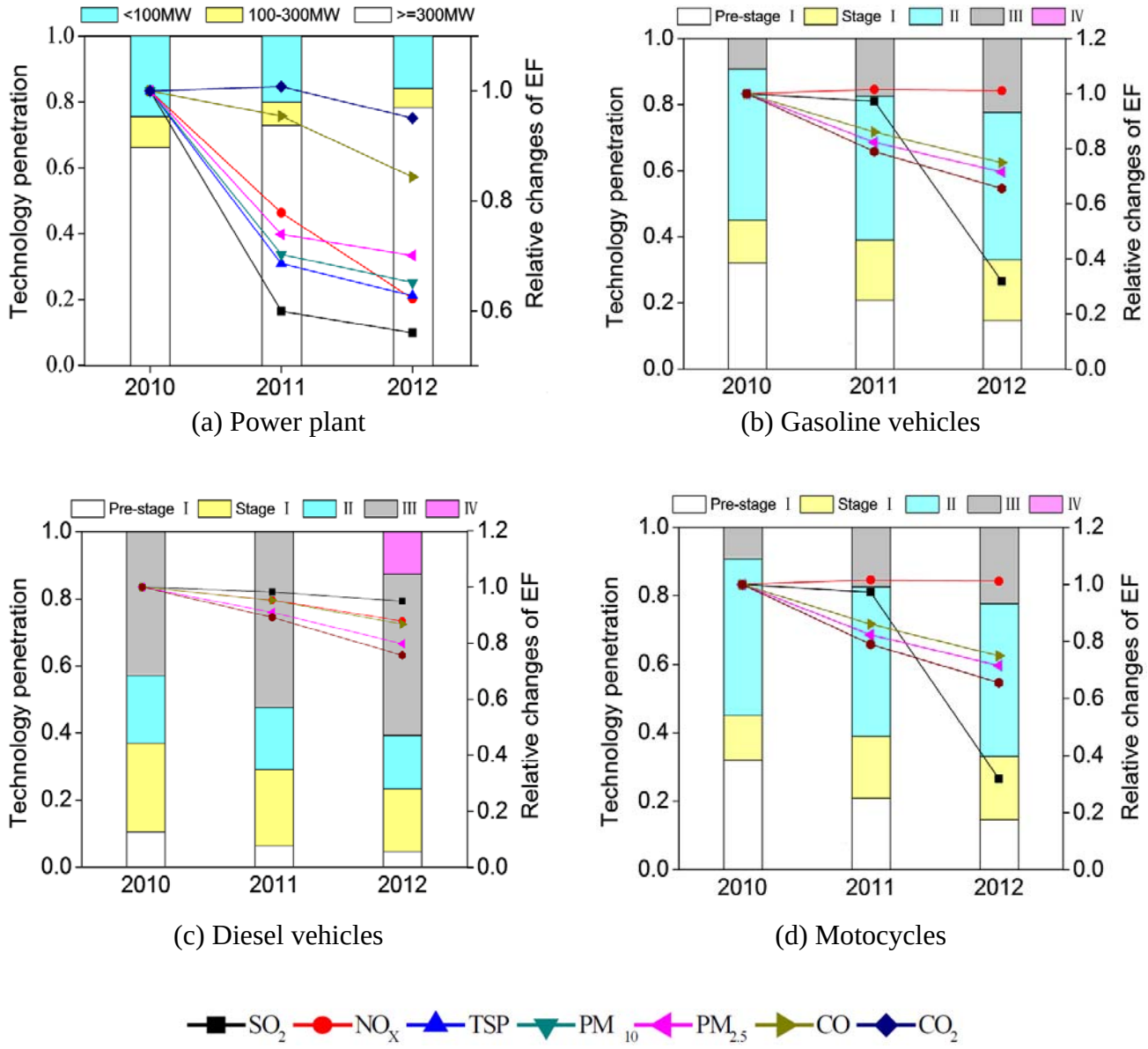

CO Caochangmen site (n=6690, 2012)
CO Shanxilu site (n=6591, 2012)
CO Caochangmen site (n=6138, 2014)
CO Shanxilu site (n=6014, 2014)
a) 2012:Caochangmen site VS Shanxilu site
b) 2014:Caochangmen site VS Shanxilu site
c) Caochangmen site: 2012 VS 2014
d) Shanxilu site: 2012 VS 2014
Frequency
CO (mg/m3)

Figure S8.


<100MW
100-300MW
>=300MW
Technology penetration
Relative changes of EF
2010
2011
2012
(a) Power plant
Pre-stage I
Stage I
II
III
IV
(b) Gasoline vehicles
(c) Diesel vehicles
(d) Motocycles
SO2
NOX
TSP
PM10
PM2.5
CO
CO2

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