Supporting Information for:

An updated emission inventory of vehicular VOCs/IVOCs in China

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5 Tables (S1, S2, S3, S4, S5)

Table S1. Previous studies on emission inventory of VOCs from vehicles in China.

Study	Target year	Target region	Target emission sources	Target pollutants	China's Transport source NMVOCs emission amount in the target year (Gg/year)
Bo et al. (2008)	1980	China	Anthropogenic sources	NMVOCs	217
Bo et al. (2008)	1985	China	Anthropogenic sources	NMVOCs	435
Bo et al. (2008)	1990	China	Anthropogenic sources	NMVOCs	807
Klimont et al. (2001)	1990	China	Anthropogenic sources	NMVOCs	2317
Tonooka et al. (2001)	1994-1995	East Asia	Anthropogenic sources	NMVOCs, CO	1477
Klimont et al. (2001)	1995	China	Anthropogenic sources	NMVOCs	3567
Li et al. (2003)	1995	China	On-road transportation	THC, NMVOCs, CH_4, CO, NO_X, CO_2, SO_2, Pb, PM_{10}, N_2O	3264
Klimont et al. (2001)	2000	China	Anthropogenic sources	NMVOCs	5071
Streets et al. (2003)	2000	Asia	Anthropogenic sources	SO_2, NO_X, CO_2, CO, CH_4, NMVOCs, BC, OC, NH_3	394.2
Liu et al. (2008)	2000	China	Anthropogenic sources	VOCs	2710
Bo et al. (2008)	2000	China	Anthropogenic sources	NMVOCs	3081
Wei et al. (2008)	2005	China	Anthropogenic sources	NMVOCs	4700
Cai et al. (2007)	2005	China	On-road transportation	CH_4, CO, CO_2, NMVOCs, NO_X, PM_{10}, SO_2	5911
Bo et al. (2008)	2005	China	Anthropogenic sources	NMVOCs	5490
Cai et al. (2009)	2005	China	On-road transportation	NMVOCs	5959

Zhang et al. (2009)	2006	Asia	Anthropogenic sources	SO_2, NO_X, CO, NMVOCs, PM_{10}, $PM_{2.5}$, BC, OC	6630
Li et al. (2014)	2006	Asia	Anthropogenic sources	NMVOCs	5475
Cao et al. (2011)	2007	China	Anthropogenic sources	$PM_{2.5}$, BC, OC, SO_2, NO_X, CO, NH_3, VOCs	4099
Klimont et al. (2001)	2010	China	Anthropogenic sources	NMVOCs	4495
Wei et al. (2011)	2010	China	Anthropogenic sources	NMVOCs	5630
Wei et al. (2011)	2015	China	Anthropogenic sources	NMVOCs	3570
Klimont et al. (2001)	2020	China	Anthropogenic sources	NMVOCs	3559
Wei et al. (2011)	2020	China	Anthropogenic sources	NMVOCs	2960

12 **Table S2. Mapping from vehicles in US to China certification level (Gasoline).**

Vehicle name	Model year	Vehicle class*	Engine size（L）	Emission Certification Standard	Test cycle	Mapping to China Emission Certification Standard	Total IVOC Emission factors (mg/kg-fuel)
PreLEV-1	1987	PC	4	Tier I	Cold UC	China1	259.11
PreLEV-2	1988	PC	2	Tier I	Cold UC	China1	1677.21
PreLEV-2	1988	PC	2	Tier I	Cold UC	China1	888.79
PreLEV-4	1989	PC	1	Tier I	Cold UC	China1	248.43
PreLEV-3	1990	M3	5	Tier I	Cold UC	China1	99.04
PreLEV-3	1990	PC	5	Tier I	Hot UC	China1	105.66
PreLEV-5	1991	PC	4	LEV	Cold UC	China1	61.72
PreLEV-8	1991	PC	4	Tier I	Cold UC	China1	147.41
PreLEV-9	1991	PC	4	Tier I	Cold UC	China1	147.81
PreLEV-10	1992	PC	3	Tier I	Cold UC	China1	166.11
PreLEV-11	1992	PC	4	Tier I	Cold UC	China1	180.84
PreLEV-14	1993	PC	5	Tier I	Cold UC	China1	150.91
PreLEV-15	1993	T2	4	Tier I	Cold UC	China1	613.58
LEV1-8	1994	PC	2	LEV1; Tier I	Cold UC	China2	235.33
LEV1-1	1996	PC	2.7	Tier I	Cold UC	China2	61.48
LEV1-1	1996	PC	2.7	Tier I	Cold UC	China2	50.11
LEV1-2	1997	PC	3	LEV	Cold UC	China2	25.08
LEV1-2	1997	PC	3	LEV	Cold UC	China2	20.05
LEV1-2	1997	PC	3	LEV	Hot UC	China2	30.46
LEV1-16	1998	PC	1.8	LEV1, TLEV	Cold UC	China3	127.22
LEV1-3	1998	PC	3	LEV	Cold UC	China2	93.10
LEV1-3	1998	PC	3	LEV	Arterial	China2	4.09
LEV1-3	1998	PC	3	LEV	Freeway	China2	26.28
LEV1-17	1999	T2	4	LEV1, NLEV	Cold UC	China3	24.92
LEV1-4	1999	PC	2	TLEV	Cold UC	China2	9.18
LEV1-19	2000	PC	3.5	LEV1	Cold UC	China3	45.36
LEV1-19	2000	PC	3.5	LEV1	Cold UC	China3	53.69
LEV1-21	2001	PC	2.2	LEV	Cold UC	China4	25.36
LEV1-24	2002	PC	5.7	LEV	Cold UC	China4	29.98
LEV1-24	2002	PC	5.7	LEV	Cold UC	China4	36.44
LEV1-25	2003	PC	3	LEV1; Tier I	Cold UC	China4	84.17
LEV1-26	2003	PC	1.8	LEV1, ULEV	Cold UC	Chian4	41.24

LEV1-6	2003	PC	3.5	LEV1, NLEV	Cold UC	China4	460.25
LEV2-8	2004	PC	2	LEV2; Tier II, Bin 8	Cold UC	Chian4	56.82
LEV2-10	2005	T2	3	LEV2; Tier II, Bin 5	Cold UC	China4	31.24
LEV2-11	2005	PC	2	LEV2, ULEV; Tier II, Bin 5	Cold UC	China4	98.81
LEV2-13	2008	PC	2	LEV2, ULEV; Tier II, Bin 5	Cold UC	China5	21.73
LEV2-15	2008	PC	3	LEV2	Cold UC	China5	21.50
LEV2-16	2008	PC	4	LEV2; Tier II, Bin 5	Cold UC	China5	7.10
LEV2-2	2008	T2	4	LEV2	Cold UC	China5	16.80
LEV2-3	2008	PC	4	LEV2	Hot UC	China5	20.76
LEV2-3	2008	PC	4	LEV2	Cold UC	China5	21.90
LEV2-18	2009	T2	6	Tier II	Cold UC	China5	27.84
LEV2-19	2009	PC	2	LEV2, ULEV; Tier II, Bin 5	Cold UC	China5	11.79
LEV2-20	2009	PC	2	LEV2, ULEV	Cold UC	China5	15.01
LEV2-4	2010	T2	4	ULEV; Tier II	Cold UC	China5	6.84
LEV2-4	2010	T2	4	ULEV; Tier II	Cold UC	China5	46.13
LEV2-23	2011	PC	n/a	LEV2, ULEV	Cold UC	China5	17.08
LEV2-5	2011	PC	2	ULEV	Cold UC	China5	28.02
LEV2-5	2011	PC	2	ULEV	Cold UC	China5	34.11
LEV2-5	2011	PC	2	ULEV	Cold UC	China5	16.37
LEV2-6	2011	PC	4	LEV2, ULEV	Cold UC	China5	20.66
LEV2-6	2011	PC	4	LEV2, ULEV	Arterial	China5	15.56
LEV2-6	2011	PC	4	LEV2, ULEV	Freeway	China5	25.84
LEV2-24	2012	M3	4	ULEV	Cold UC	China5	18.89
LEV2-7	2012	PC	2	PZEV	Cold UC	China5	39.37
LEV1-9	N/A	N/A	N/A	N/A	Cold UC	China2	381.98

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Table S3. Mapping from vehicles in US to China certification level (Diesel).

Vehicle ID	Model year	Mileage	Engine displacement (L)	Average fuel economy(MPG)	After-treatment	Mapping to China Emission Certification Standard	Total IVOC emission factors
1	2010	11000	14.9	4.5	DPF+SCR+DOC	China6	104.85
1	2010	11000	14.9	4.5	DPF+SCR+DOC	China6	16.67
2	2007	22000	12.8	4.9	DPF+DOC	China5	1066.94
2	2007	22000	12.8	4.9	DPF+DOC	China5	18.72
2	2007	22000	12.8	4.9	DPF+DOC	China5	25.11
2	2007	22000	12.8	4.9	DPF+DOC	China5	37.14
2	2007	22000	12.8	4.9	DPF+DOC	China5	30.54
2	2007	22000	12.8	4.9	DPF+DOC	China5	22.77
3	2006	94000	10.8	4.3	NONE	China4	3448.35
3	2006	94000	10.8	4.3	NONE	China4	626.95
3	2006	94000	10.8	4.3	NONE	China4	565.07
3	2006	94000	10.8	4.3	NONE	China4	703.41
3	2006	94000	10.8	4.3	NONE	China4	3072.29
3	2006	94000	10.8	4.3	NONE	China4	3858.87
3	2006	94000	10.8	4.3	NONE	China4	592.03
3	2006	94000	10.8	4.3	NONE	China4	687.64
3	2006	94000	10.8	4.3	NONE	China4	685.02
3	2006	94000	10.8	4.3	NONE	China4	5353.78
3	2006	94000	10.8	4.3	NONE	China4	898.63
3	2006	94000	10.8	4.3	NONE	China4	796.78
4	2005	66000	6.6	11.8	DOC*	China4	767.83
5	2001	159000	5.9	13.7	NONE	China3	631.35

17 **Table S4. VOCs emission factors used in this study (mg/km).**

Passenger vehicles						
	China 0	China 1	China 2	China 3	China 4	China 5
LDGTAs	3.840	1.368	0.963	0.454	0.277	0.257
LDDTAs	0.785	0.071	0.046	0.024	0.016	0.016
LDABs	3.788	0.433	0.398	0.115	0.066	0.293
LDGPVs	2.685	0.663	0.314	0.191	0.075	0.056
LDDPVs	0.785	0.071	0.046	0.024	0.016	0.016
LDAPVs	2.236	0.236	0.164	0.094	0.062	0.091
MDGBUs	5.144	5.255	1.980	0.869	0.418	0.418
MDDBUs	2.668	0.576	0.351	0.283	0.107	0.054
MDABs	3.840	3.200	2.860	1.720	1.192	1.192
MDGPVs	3.695	2.567	1.443	0.373	0.107	0.107
MDDPVs	1.493	1.425	0.425	0.364	0.383	0.383
MDAPVs	1.920	1.600	1.430	0.860	0.596	0.596
HDGBUs	5.144	5.255	1.980	0.869	0.418	0.418
HDDBUs	2.668	0.576	0.351	0.283	0.107	0.054
HDABs	3.840	3.200	2.860	1.720	1.192	1.192
HDGPVs	5.144	5.255	1.980	0.869	0.418	0.418
HDDPVs	2.668	0.576	0.351	0.283	0.107	0.054
HDAPVs	3.840	3.200	2.860	1.720	1.192	1.192
Trucks						
		China 0	China 1	China 2	China 3	China 4/ 5
Urban road	LDGTs	5.391	3.593	2.389	0.637	0.176
	LDDTs	2.267	2.205	1.411	0.384	0.194
	MDGTs	7.441	7.326	3.268	1.482	0.619
	MDDTs	4.863	1.742	0.455	0.219	0.111
	HDGTs	7.295	7.306	3.249	1.464	0.600
	HDDTs	4.413	0.970	0.562	0.276	0.139
Provincial road	LDGTs	4.040	2.693	1.841	0.530	0.147
	LDDTs	1.699	1.653	1.087	0.320	0.162
	MDGTs	5.577	5.490	2.449	1.111	0.464
	MDDTs	3.645	1.306	0.341	0.164	0.083
	HDGTs	5.467	5.475	2.435	1.097	0.450
	HDDTs	3.308	0.727	0.421	0.207	0.105
National road	LDGTs	4.376	2.916	1.924	0.549	0.152
	LDDTs	1.840	1.790	1.136	0.331	0.167
	MDGTs	6.040	5.946	2.652	1.203	0.503
	MDDTs	3.947	1.414	0.369	0.178	0.090
	HDGTs	5.921	5.930	2.637	1.188	0.487
	HDDTs	3.582	0.787	0.456	0.224	0.113
Freeway	LDGTs	4.119	2.745	1.837	0.536	0.148

	LDDTs	1.732	1.685	1.085	0.323	0.163
	MDGTs	5.685	5.597	2.497	1.132	0.473
	MDDTs	3.716	1.331	0.348	0.168	0.085
	HDGTs	5.574	5.582	2.483	1.118	0.458
	HDDTs	3.372	0.741	0.429	0.211	0.107
County road	LDGTs	7.010	4.673	3.059	0.798	0.221
	LDDTs	2.948	2.868	1.806	0.482	0.243
	MDGTs	9.677	9.527	4.250	1.927	0.805
	MDDTs	6.324	2.266	0.592	0.285	0.145
	HDGTs	9.487	9.501	4.226	1.903	0.780
	HDDTs	5.740	1.261	0.731	0.358	0.181

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20 **Table S5. IVOCs emission factors used in this study (mg/km).**

Passenger vehicles					
	China 0/1	China 2	China 3	China 4	China 5
LDDTAs/LDGTAs/LDGPVs/LDDPVs	0.09138	0.00962	0.00796	0.00394	0.00145
MDGBUs/MDDBUs/MDGPVs/MDDPVs	0.01809	0.00420	0.00515	0.00515	0.00207
HDGBUs/HDDBUs/HDGPVs/HDDPVs	0.01628	0.00434	0.00434	0.02469	0.00224
Trucks					
		China 0/1	China 2	China 3	China 4/5
Urban road/Provincial road/National road/Freeway/County road	LDGTs	0.07002	0.00260	0.00277	0.00226
	LDDTs	0.05252	0.05252	0.07415	0.07415
	MDGTs	0.10503	0.00390	0.00416	0.00339
	MDDTs	0.07878	0.07878	0.11123	0.11123
	HDGTs	0.10503	0.00390	0.00416	0.00339
	HDDTs	0.07878	0.07878	0.11123	0.11123

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