

Tables and Figures

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Figure S1. Anthropogenic emissions between 2010-2017 of major regions over the globe (China, India, Other East Asia, Other South Asia, Southeast Asia, United States, OECD-Europe). Emissions over Asia are derived from MIXv2, and emissions over the rest of the world are estimated by EDGARv6

Figure S2. Emissions by latitude bands from 2010 to 2017 for NO_x, NMVOC, CO and PM_{2.5}, complemented to Fig. 10

Table S1. Source profiles used in development of MIXv2^a.

Sector	Subsector	Source	Source profiles ^b	Activity	IPCC code
power	power	raw coal	1178, Shi et al., 2015	fuel consumption	1A1a
	power	cleaned coal	1178, Shi et al., 2015	fuel consumption	1A1a
	power	other washed coal	1178, Shi et al., 2015	fuel consumption	1A1a
	power	briquettes	1178, Shi et al., 2015	fuel consumption	1A1a
	power	diesel oil	2	fuel consumption	1A1a
	power	fuel oil	5647	fuel consumption	1A1a
	power	LPG	4	fuel consumption	1A1a
	power	NG	3, 1001	fuel consumption	1A1a
industry	industrial coal use	raw coal	1178, 1185, Liu et al.,2008, Shi et al.,2015	fuel consumption	1A2, 1A1c
	industrial coal use	cleaned coal	1178, 1185, Liu et al.,2008, Shi et al.,2015	fuel consumption	1A2
	industrial coal use	other washed coal	1178, 1185, Liu et al.,2008, Shi et al.,2015	fuel consumption	1A2
	industrial coal use	briquettes	1178, 1185, Liu et al.,2008, Shi et al.,2015	fuel consumption	1A2
	industrial coal use	coke	1178, 1185, Liu et al.,2008, Shi et al.,2015	fuel consumption	1A2
	industrial coal use	cement coal use	1185, Liu et al.,2008	fuel consumption	1A2
	industrial coal use	lime coal use	1185, Liu et al.,2008	fuel consumption	1A2
	industrial coal use	brick coal use	1185, Liu et al.,2008	fuel consumption	1A2
	industrial coal use	synthetic ammonia by coal	7128, 7129, 7136, 7149	fuel consumption	1A2
	industrial other fuel combustion	fuel oil	5647	fuel consumption	1A2
	industrial other fuel combustion	LPG	4	fuel consumption	1A2
	industrial other fuel combustion	NG	3	fuel consumption	1A2
	industrial other fuel combustion	coke oven gas	5	fuel consumption	1A2
	industrial other fuel combustion	other gas	5	fuel consumption	1A2
	chemical industry	flat glass	1185, Liu et al.,2008	production	2B
	chemical industry	glass products	1185, Liu et al.,2008	production	2B

	chemical industry	NG production	8949	production	1B2b
	chemical industry	NG distribution	8950	NG distribution	1B2b
	chemical industry	carbon black	1002	production	2B
	chemical industry	pulp	8783, 8789, 7101, 7102, 7103	production	2B
	chemical industry	varnish paint production	7105, 1094	production	2B
	chemical industry	architechture paint prodcution	7105, 1094	production	2B
	chemical industry	printing ink production	72	production	2B
	chemical industry	glue production	2423	production	2B
	chemical industry	asphalt production	Liu et al.,2008	production	2B
	chemical industry	rubber	1008	production	2B
	chemical industry	tyres	272, 273, 274	production	2B
	chemical industry	polystyrene	1004, Hsu et al.,2007	production	2B
	chemical industry	ethylene	2461	production	2B
	chemical industry	LDPE	2547	production	2B
	chemical industry	HDPE	2547	production	2B
	chemical industry	PVC	1091	production	2B
	chemical industry	poly'prop	68, Mo et al.,2015	production	2B
	chemical industry	synthetic fiber	1092	production	2B
	chemical industry	wool	1095, 1096	production	2B
	chemical industry	silk	1095, 1096	production	2B
	chemical industry	cloth	1095, 1096	production	2B
	chemical industry	spirits	1070, 1071	production	2
	oil production distribution and refinery	crude oil production	1207, 1212	oil production	1B2a
	oil production distribution and refinery	crude oil handle	296, 1208, 2487	oil handling	1B2a
	oil production distribution and refinery	oil refinery	Liu et al.,2008	crude oil input	1B2a

	oil production distribution and refinery	oil depot-gasoline	Liu et al.,2008, Zhang et al.,2013, Wu et al.,2015	gasoline distribution	1B2a
	oil production distribution and refinery	oil depot-diesel	Liu et al.,2008	diesel distribution	1B2a
	oil production distribution and refinery	oil station-gasoline	Zhang et al.,2013	gasoline refueling	1B2a
	oil production distribution and refinery	oil station-diesel	Zhang et al.,2013	diesel refueling	1B2a
	other industrial process	sintering, iron and steel	13, Tsai et al.,2008	production	2C1
	other industrial process	non-ferrous metal	1089	production	2C
	other industrial process	cement, lime and brick	n/a	production	2A1, 2A2, 2A7
	other industrial process	coke	Shi et al.,2015	production	2
	other industrial process	cake	8538	production	2
	other industrial process	biscuit	8538	production	2
	other industrial process	sugar	8538	production	2
	other industrial process	beer	1070, 1071	production	2
	other industrial process	wine	1070, 1071	production	2
	industrial paint use	architecture interior wall coating	Wang et al.,2014	solvent used	3A
	industrial paint use	architecture other paint	Liu et al.,2008	solvent used	3A
	industrial paint use	new car varnish paint	Yuan et al.,2010	solvent used	3A
	industrial paint use	vehicle refurbish paint	Wang et al.,2014	solvent used	3A
	industrial paint use	decorations wood	Yuan et al.,2010	solvent used	3A
	industrial paint use	wood furniture	Zheng et al.,2013	solvent used	3A
	industrial paint use	other industry paint	1013	solvent used	3B
	solvent use other than paint	printing ink	Yuan et al.,2010, Zheng et al.,2013, Wang et al.,2014	solvent used	3C
	solvent use other than paint	printing cleaning gasoline solvent	Liu et al.,2008	solvent used	3B
	solvent use other than paint	passenger vehicle treated-dewax	1194	vehicle ownership	3C

	solvent use other than paint	passenger vehicle treated-reseal	1194	vehicle ownership	3C
	solvent use other than paint	wood production treatment	2404	solvent used	3C
	solvent use other than paint	pharmaceutical production	3040, 3144	solvent used	3C
	solvent use other than paint	pesticide use	76, 3001	solvent used	3C
residential	residential coal combustion	raw coal	1185, Tsai et al.,2003, Liu et al.,2008, Mo et al.,2016	fuel consumption	1A4b
	residential coal combustion	other washed coal	1185, Tsai et al.,2003, Liu et al.,2008, Mo et al.,2016	fuel consumption	1A4b
	residential coal combustion	briquettes	1185, Tsai et al.,2003, Liu et al.,2008, Mo et al.,2016	fuel consumption	1A4b
	residential biofuel combustion	wood	Tsai et al.,2003, Liu et al.,2008, Wang et al.,2009	fuel consumption	1A4bx
	residential biofuel combustion	crop residual	Tsai et al.,2003, Wang et al.,2009, Mo et al.,2016	fuel consumption	1A4bx
	residential other fuel combustion	LPG	Tsai et al., ,2003	fuel consumption	1A4b
	residential other fuel combustion	NG	Tsai et al., ,2003	fuel consumption	1A4b
	waste treatment	fill	202, 3002	amount of waste	6A
	waste treatment	incineration	122	amount of waste	6C
	domestic solvent use	domestic solvent	197	population	3C
	domestic solvent use	dry clean C2Cl4 usage	1193, 85	solvent used	3C
	domestic solvent use	glue use	1020, 1088, 2423, 3004, 3005, 3006, 3007, 3008, 3009, 3010, 3011, 3012, 3013, 3142, 8523, 8524, 8525	solvent used	3C
transportation	onroad gasoline	heavy duty truck	1186, Schauer et al.,2002	gasoline fuel	1A3b
	onroad gasoline	medium duty truck	1186, Schauer et al.,2002	gasoline fuel	1A3b
	onroad gasoline	light duty truck	4557, 1203, 8756, 6001, Duffy et al.,1999, Schauer et al.,2002, Liu et al.,2008, Wang et al.,2013, Dai et al.,2013	gasoline fuel	1A3b
	onroad gasoline	mini truck	4557, 1203, 8756, 6001, Duffy et al.,1999, Schauer et al.,2002, Liu et al.,2008, Wang et al.,2013, Dai et al.,2013	gasoline fuel	1A3b
	onroad gasoline	heavy duty bus	1186, Schauer et al.,2002	gasoline fuel	1A3b
	onroad gasoline	medium duty bus	1186, Schauer et al.,2002	gasoline fuel	1A3b
	onroad gasoline	light duty bus	4557, 1203, 8756, 6001, Duffy et al.,1999, Schauer et al.,2002, Liu	gasoline fuel	1A3b

			et al.,2008, Wang et al.,2013, Dai et al.,2013		
	onroad gasoline	mini bus	4557, 1203, 8756, 6001, Duffy et al.,1999, Schauer et al.,2002, Liu et al.,2008, Wang et al.,2013, Dai et al.,2013	gasoline fuel	1A3b
	onroad gasoline	motorcycle	Liu et al.,2008, Yao et al.,2013	gasoline fuel	1A3b
	onroad gasoline	evaporatation	Liu et al.,2008	gasoline fuel	1A3b
	onroad diesel	heavy duty truck	4674, 8775, Schauer et al.,1999, Mo et al.,2016	diesel fuel	1A3b
	onroad diesel	medium duty truck	4674, 8775, Schauer et al.,1999, Mo et al.,2016	diesel fuel	1A3b
	onroad diesel	light duty truck	1201, Liu et al.,2008, Tsai et al.,2012	diesel fuel	1A3b
	onroad diesel	mini truck	1201, Liu et al.,2008, Tsai et al.,2012	diesel fuel	1A3b
	onroad diesel	heavy duty bus	4674, 8775, Schauer et al.,1999, Mo et al.,2016	diesel fuel	1A3b
	onroad diesel	medium duty bus	4674, 8775, Schauer et al.,1999, Mo et al.,2016	diesel fuel	1A3b
	onroad diesel	light duty bus	1201, Liu et al.,2008, Tsai et al.,2012	diesel fuel	1A3b
	offroad diesel	locomotive	95331, 95332, 95333	diesel fuel	1A3c
	offroad diesel	in-land waterway	5677, 5678	diesel fuel	1A4c
	offroad diesel	3-wheelers	Yao et al.,2015	diesel fuel	1A4c
	offroad diesel	low-speed truck	Yao et al.,2015	diesel fuel	1A4c
	offroad diesel	agricultural machinery	95331, 95332, 95333	diesel fuel	1A4c
	offroad diesel	construction machinery	95331, 95332, 95333	diesel fuel	1A4c
agriculture	livestock	livestock	n/a	animal population	4D
	fertilizer use	synthetic fertilizer	n/a	fertilizer consumption	4B
open biomass burning	agriculture in-field burning	crop residue	Akagi et al., 2011	biomass burned	4F
	fires	peat	Akagi et al., 2011	biomass burned	5D
	fires	tropical forest	Akagi et al., 2011	biomass burned	4E
	fires	savanna	Akagi et al., 2011	biomass burned	4E
	fires	extratropical forest	Akagi et al., 2011	biomass burned	5A
	fires	boreal forest	Akagi et al., 2011	biomass burned	5A
	fires	grassland	Akagi et al., 2011	biomass burned	5C
shipping	domestic shipping	inland shipping	Xiao et al., 2018	fuel consumption	1A3d
	international shipping	international shipping	Xiao et al., 2018	fuel consumption	1C2

Note:

^a Derived from Li et al. (2019) with updates on open biomass burning and shipping.

^a The numbers represent “P_NUMBER” of profiles in the SPECIATE v4.5 database.

Table S2. Species mapping from SAPRC99 to SAPRC07, used for the Republic of Korea and Hong Kong (China) NMVOC speciation.

SAPRC07 species	mapping formula from SAPRC99
SAPRC07_CH4	SAPRC99_CH4
SAPRC07_ALK1	SAPRC99_ALK1
SAPRC07_ALK2	SAPRC99_ALK2-SAPRC07_ACYE-SAPRC07_FACD-AACD-PACD
SAPRC07_ALK3	SAPRC99_ALK3
SAPRC07_ALK4	SAPRC99_ALK4
SAPRC07_ALK5	SAPRC99_ALK5
SAPRC07_ETHE	SAPRC99_ETHE
SAPRC07_OLE1	SAPRC99_OLE1
SAPRC07_OLE2	SAPRC99_OLE2
SAPRC07_ISOP	SAPRC99_ISOP
SAPRC07_TERP	SAPRC99_TERP
SAPRC07_BENZ	Based on the ratio of SAPRC07_BENZ/SAPRC99_ARO1 from MEIC by sector
SAPRC07_ARO1	$SAPRC99_ARO1 - 0.295 * SAPRC07_BENZ$
SAPRC07_ARO2	SAPRC99_ARO2
SAPRC07_ACYE	Based on the ratio of SAPRC07_ACYE/SAPRC09_ALK2 from MEIC by sector
SAPRC07_HCHO	SAPRC99_HCHO
SAPRC07_CCHO	SAPRC99_CCHO
SAPRC07_RCHO	SAPRC99_RCHO
SAPRC07_BALD	SAPRC99_BALD
SAPRC07_ACET	SAPRC99_ACET
SAPRC07_MEK	SAPRC99_MEK
SAPRC07_PRD2	SAPRC99_PRD2
SAPRC07_MEOH	SAPRC99_MEOH
SAPRC07_FACD	Based on the ratio of FACD/HCHO from MEIC by sector
SAPRC07_AACD	Based on the ratio of AACD/HCHO from MEIC by sector
SAPRC07_PACD	Based on the ratio of PACD/HCHO from MEIC by sector
SAPRC07_GLY	SAPRC99_GLY
SAPRC07_MGLY	SAPRC99_MGLY
SAPRC07_BACL	SAPRC99_BACL
SAPRC07_CRES	$SAPRC99_CRES + SAPRC99_PHEN$
SAPRC07_MACR	SAPRC99_MACR
SAPRC07_MVK	SAPRC99_MVK
SAPRC07_IPRD	SAPRC99_IPRD
SAPRC07_RNO3	Based on the ratio of SAPRC07_RNO3/SAPRC07_NVOL from MEIC by sector
SAPRC07_NVOL	SAPRC99_NVOL
SAPRC07_NROG	$SAPRC99_NROG - 0.705 * SAPRC07_BENZ$

Table S4. Mapping from SAPRC07 species to chemical groups for Fig. 11.

Species	Groups
SAPRC07_CH4	n/a
SAPRC07_ALK1	alkanes
SAPRC07_ALK2	alkanes
SAPRC07_ALK3	alkanes
SAPRC07_ALK4	alkanes
SAPRC07_ALK5	alkanes
SAPRC07_ETHE	alkenes
SAPRC07_OLE1	alkenes
SAPRC07_OLE2	alkenes
SAPRC07_ISOP	alkenes
SAPRC07_TERP	alkenes
SAPRC07_BENZ	aromatics
SAPRC07_ARO1	aromatics
SAPRC07_ARO2	aromatics
SAPRC07_ACYE	alkynes
SAPRC07_HCHO	aldehydes
SAPRC07_CCHO	aldehydes
SAPRC07_RCHO	aldehydes
SAPRC07_BALD	aldehydes
SAPRC07_ACET	ketones
SAPRC07_MEK	ketones
SAPRC07_PRD2	ketones
SAPRC07_MEOH	ovocs
SAPRC07_FACD	ovocs
SAPRC07_AACD	ovocs
SAPRC07_PACD	ovocs
SAPRC07_GLY	aldehydes
SAPRC07_MGLY	aldehydes
SAPRC07_BACL	ketones
SAPRC07_CRES	ovocs
SAPRC07_MACR	aldehydes
SAPRC07_MVK	aldehydes
SAPRC07_IPRD	aldehydes
SAPRC07_RNO3	others
SAPRC07_NVOL	others
SAPRC07_NROG	others

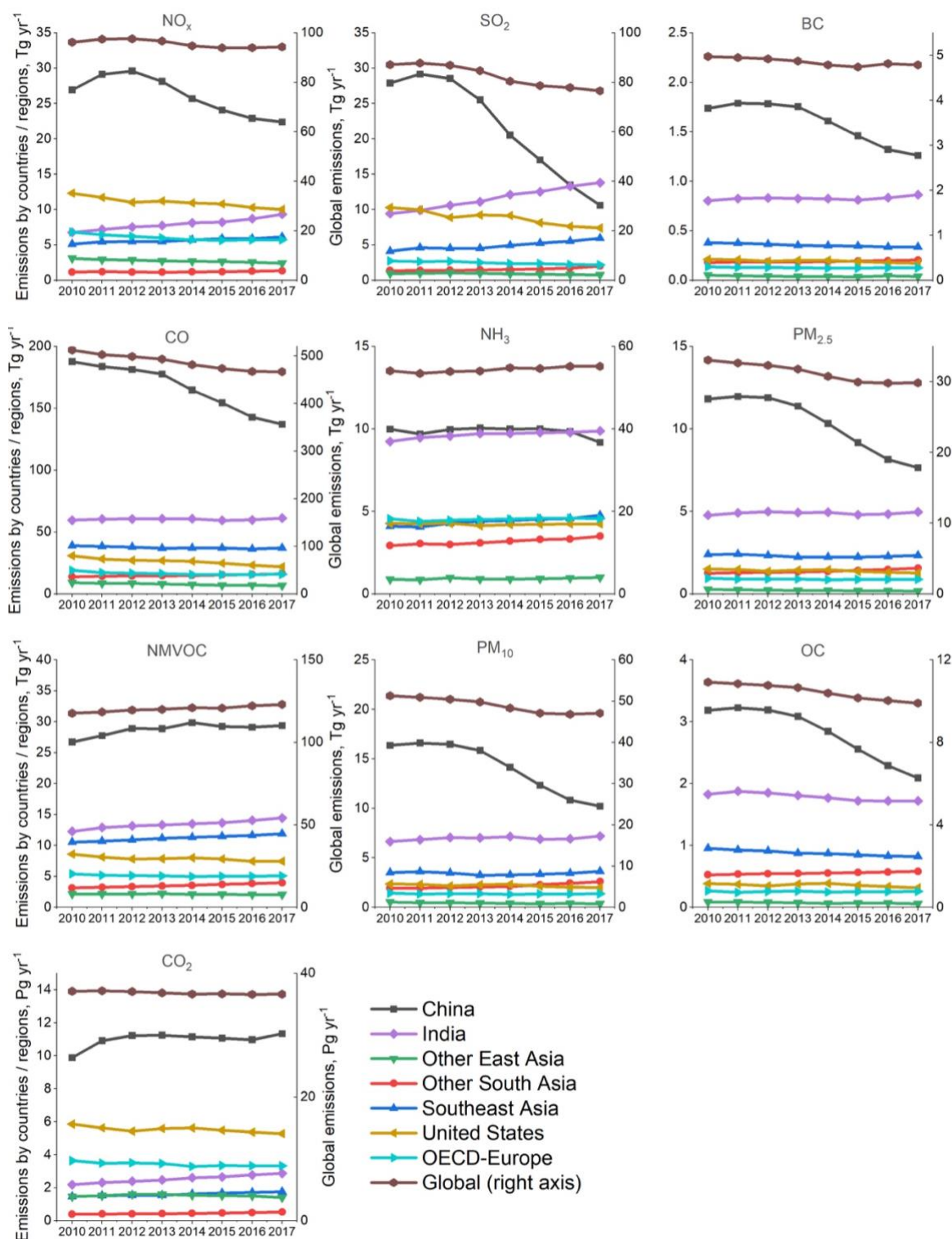


Figure S1. Anthropogenic emissions between 2010-2017 of major regions over the globe (China, India, Other East Asia, Other South Asia, Southeast Asia, United States, OECD-Europe). Emissions over Asia are derived from MIXv2, and emissions over the rest of the world are estimated by EDGARv6.

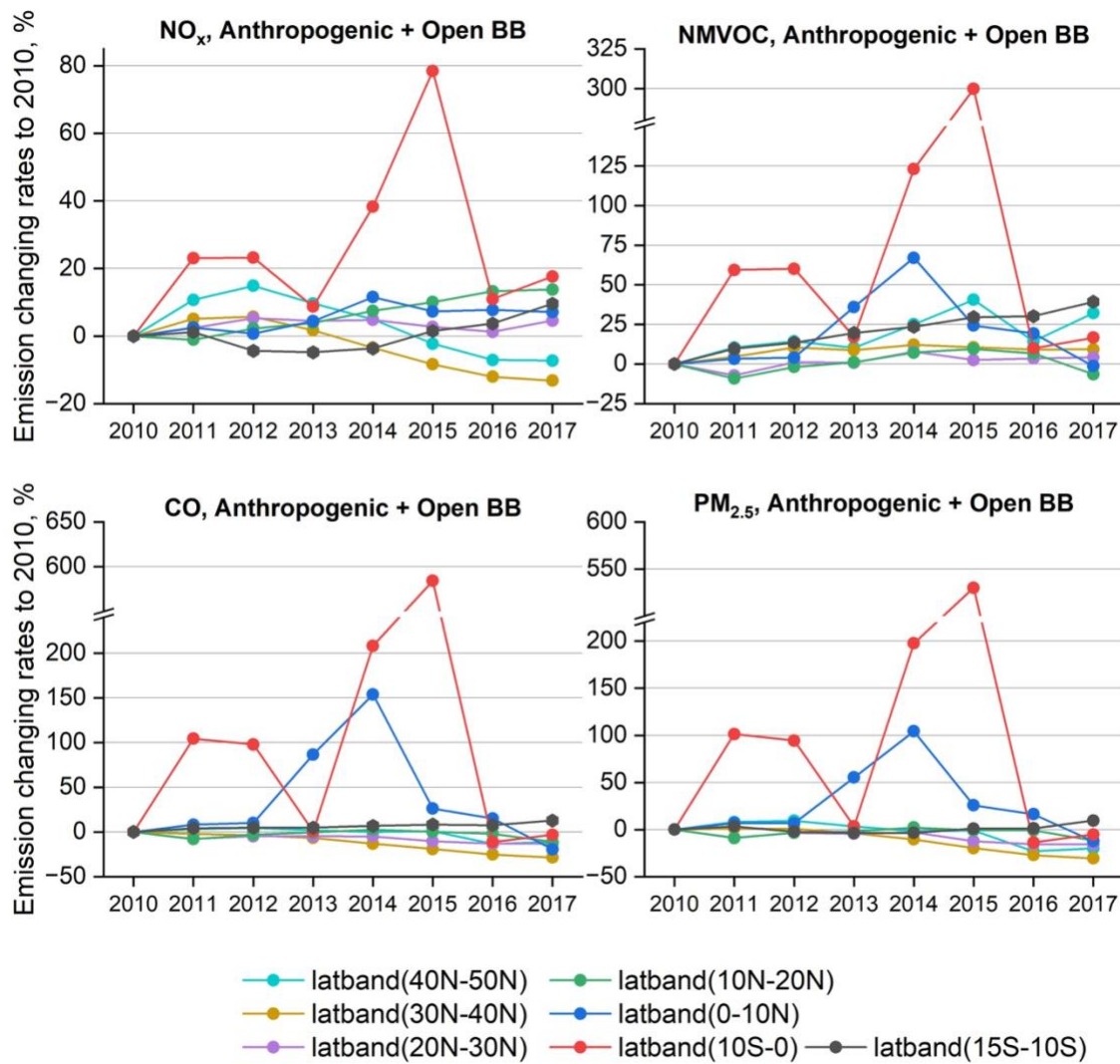


Figure S2. Emissions by latitude bands from 2010 to 2017 for NO_x , NMVOC, CO and $\text{PM}_{2.5}$, complemented to Fig. 10.

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