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Modeling of polycyclic aromatic hydrocarbons (PAHs) from global to regional scales: model development (IAP-AACM_PAH v1.0) and investigation of health risks in 2013 and 2018 in China

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Table S1. The standard values and chemical properties of soil.

Parameter	Symbol	Units	Standard value
Bulk density	ρ_s	kg m^{-3}	[a]1350
Soil depth	z_s	m	[a]0.15
Organic carbon fraction	f_{oc}	kg kg^{-1}	[a]0.0125
Air diffusion coefficient	D_G^{air}	m^2 s^{-1}	[a]5.0×10^{-6}
Liquid diffusion coefficient	D_L^{water}	m^2 s^{-1}	[a]5.0×10^{-10}
Air content	a	m^3 m^{-3}	[a]0.2
Water content	l	m^3 m^{-3}	[a]0.3
Degradation rate	k_{soil}	s^{-1}	[b]1.00×10^{-8}

(a) Jury et al. (1983); (b) Finlayson-Pitts and Pitts (2000) and Klöpffer et al. (2007).

Table S2. The parameters used in the ILCR modle for different age groups [a].

Parameter	Units	Children	Women	Men
IR (Inhalation rate)	$m^3 \cdot d^{-1}$	10.8	14.5	17.7
EF (Exposure duration)	$d \cdot year^{-1}$	350	350	350
ED (Exposure period)	$year$	6	24	24
BW (Body weight)	kg	21.8	56.8	65.0
SA (Skin exposed surface area)	cm^2	1600	4350	4350
ABS (Skin absorption factor)	dimensionless	0.13	0.13	0.13
AT (average exposure time)	d	25550	25550	25550
AF (Dermal adherence rate)	$mg \cdot cm^{-2} \cdot d^{-1}$	0.04	0.02	0.02
CF (Conversion factor)	dimensionless	10^{-6}	10^{-6}	10^{-6}
SFO_{inh} [b] (carcinogenic slope factor of inhalation)	$kg \cdot day \cdot mg^{-1}$	3.14	3.14	3.14
SFO_{der} [b] (carcinogenic slope factor of dermal contact)	$kg \cdot day \cdot mg^{-1}$	37.47	37.47	37.47

(a) ChinaMEP, 2013. (b) Hussain et al., 1998.

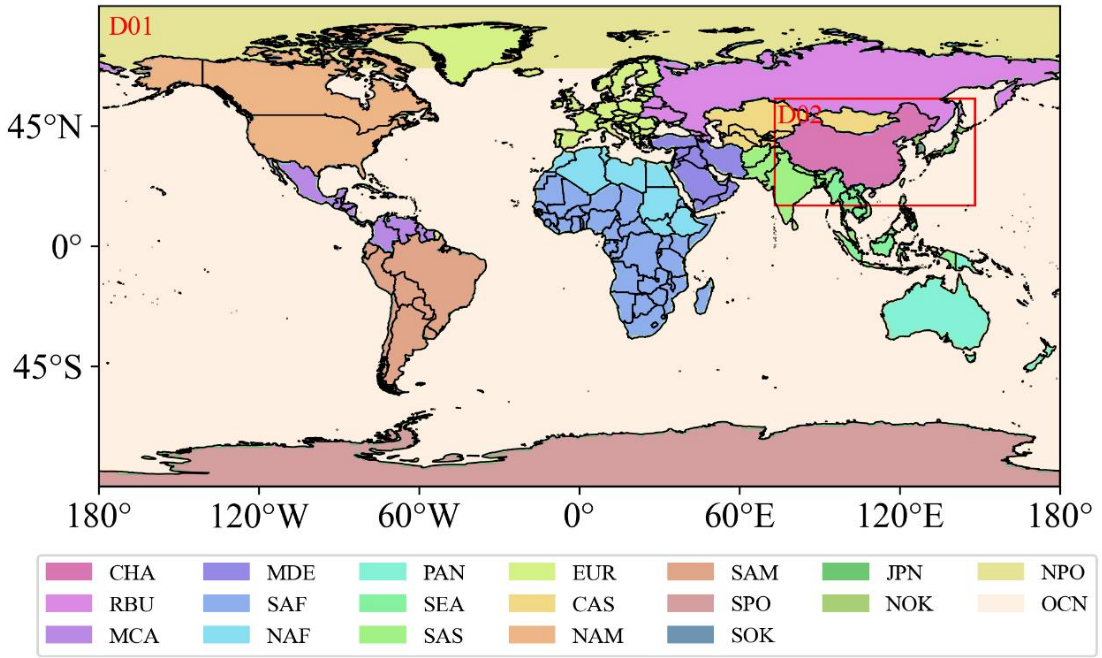

Figure S1. The nested domains (red box) and the division of Global.

Table S3. The definition of regions in the world.

Region	Definition
CHA	China
RBU	Russia, Belarussia, Ukraine
MCA	Mexico, Central America, Caribbean, Guyanas, Venezuela, Colombia
MDE	Middle East
SAF	Southern Africa
NAF	Northern Africa, Sahara, Sahel
PAN	Pacific, Australia, New Zealand
SEA	South East Asia
SAS	South Asia
EUR	Europe
CAS	Central Asia, Mongolia
NAM	United States + Canada
SAM	South America
SPO	Antarctic

SOK	South Korea
JPN	Japan
NOK	North Korea
NPO	the ocean north of 66.5° N
OCN	Non-arctic Ocean

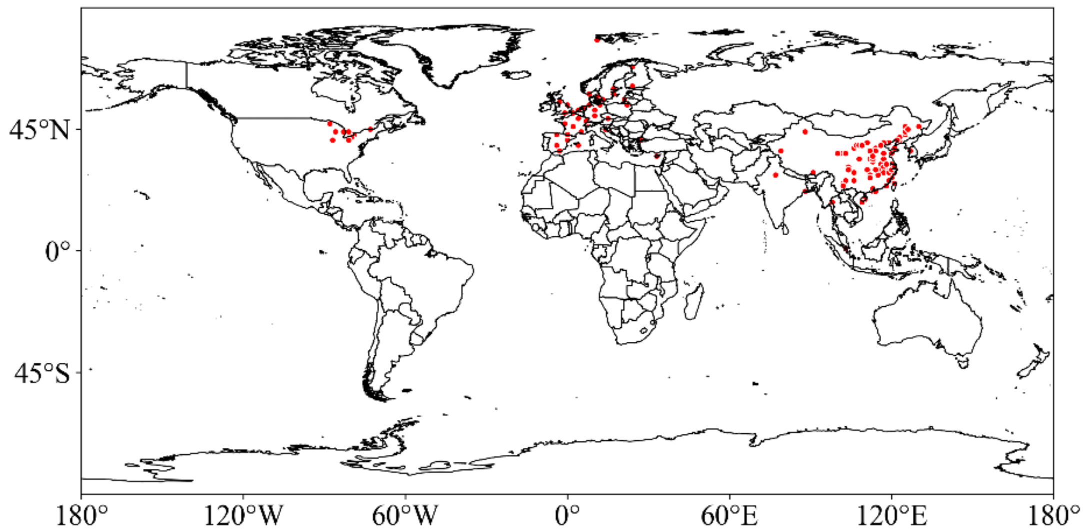

Figure S2. The spatial distribution of the BaP observations

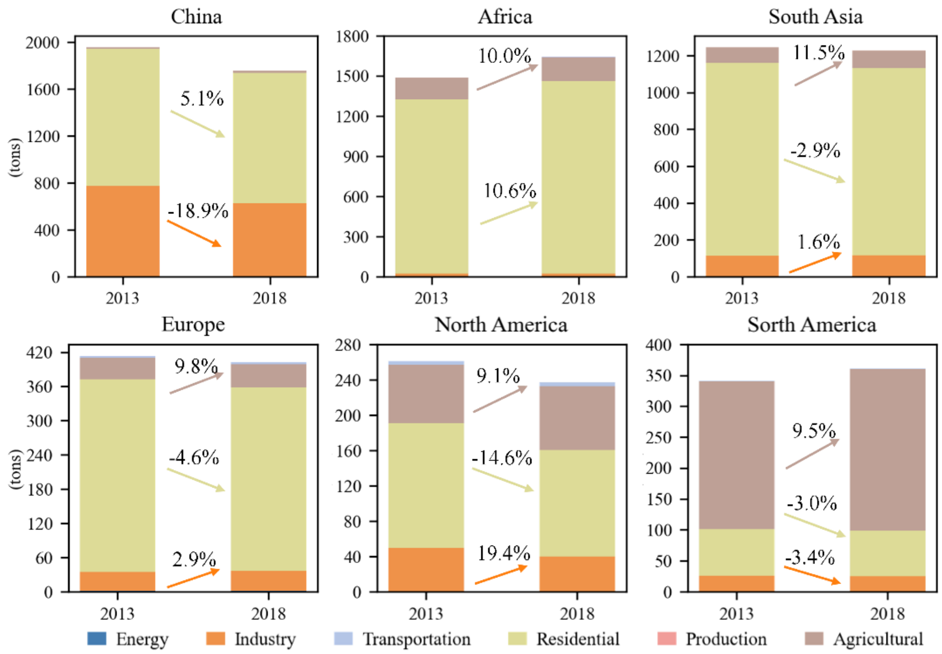

Figure S3. Emissions and changes for different sectors in China, Africa, South Asia, Europe, North America, and Sorth America in 2013 and 2018

Table S4. Details of monitoring sites in Europe [c].

Country	Code	Latitude	Longitude
Belgium	B13	51°0'58" N	2°34'56" E
Croatia	H02	45°54'0" N	15°58'0" E
Cyprus	C02	35°2'20" N	33°3'29" E
Czech Republic	C03	49°35'0" N	15°5'0" E
Germany	D01	54°55'32" N	8°18'35" E
	D02	52°48'8" N	10°45'34" E
	D03	47°54'53" N	7°54'31" E
	D08	50°39'0" N	10°46'0" E
	D09	54°26'0" N	12°44'0" E
Spain	E01	39°32'49" N	4°21'2" W
	E06	39°52'3" N	4°19'19" E
	E07	37°14'14" N	3°32'3" W
	E08	43°26'32" N	4°51'1" W
	E14	41°23'33" N	0°44'3" E
Finland	F18	60°31'48" N	27°40'3" E
	F36	68°0'0" N	24°14'23" E
	F50	61°51'0" N	24°17'0" E
France	R08	48°30'0" N	7°8'0" E
	R09	49°54'0" N	4°38'0" E
	R13	43°37'0" N	0°11'0" E
	R23	44°34'10" N	5°16'44" E
	R24	47°49'55" N	1°50'11" W
	R25	46°48'53" N	2°36'36" E
Great Britain	G14	54°20'4" N	0°48'27" W
	G55	51°8'59" N	1°26'18" W
	G36	51°34'23" N	1°19'0" W
	G48	55°47'31" N	3°14'34" W

Latvia	L10	56°9'44" N	21°10'23" E
Netherlands	N09	53°33'4" N	6°27'68" E
	N91	52°29'66" N	4°51'9" E
Norway	N02	58°23'0" N	8°15'0" E
	N42	78°54'0" N	11°53'0" E
Poland	P05	54°7'3" N	22°2'17" E
	P09	53°39'44" N	17°56'2" E
Slovenia	S08	45°33'45" N	14°51'45" E
Sweden	S11	56°1'0" N	13°9'0" E
	S12	58°48'0" N	17°23'0" E
	S14	57°23'38" N	11°55'50" E
	S20	56°2'44" N	13°8'80" E
	S22	60°5'9" N	17°30'19" E

Table S5. Details of monitoring sites in Asia, the United States, and Canada.

Location	Latitude	Longitude	Sampling time	Area type	Reference
Beijing	39.93°N	116.34°E	2013	Urban	Liu et al., 2017
Chengdu	30.64°N	104.08°E	2013	Urban	Liu et al., 2017
Lanzhou	36.05°N	103.86°E	2013	Urban	Liu et al., 2017
Wuhan	30.53°N	114.37°E	2013	Urban	Liu et al., 2017
Taiyuan	37.54°N	112.33°E	2013	Urban	Liu et al., 2017
Xinxiang	35.33°N	113.91°E	2013	Urban	Liu et al., 2017
Guangzhou	23.15°N	113.36°E	2013	Urban	Liu et al., 2017
Nanjing	32.06°N	118.8°E	2013	Urban	Liu et al., 2017
Shanghai	31.29°N	121.5°E	2013	Urban	Liu et al., 2017
Jinan	36.60°N	117.01°E	2014	Urban	Jiao et al., 2016
Huangshi	30.17°N	115.0°E	2013	Urban	Hu et al., 2018
Fushun	41.86°N	123.79°E	2013	Urban	Zhao et al., 2014
Huainan	32.6°N	116.9°E	2013	Urban	Hu et al., 2016

Hohhot	40.8°N	111.6°E	2015	Urban	Wei et al., 2017
Jiaozuo	35.2°N	113.27°E	2013	Urban	Ji et al., 2017
Hefei	31.82°N	117.22°E	2013	Urban	Zheng et al., 2014
Haikou	19.98°N	110.33°E	2014	Urban	Liu et al., 2016
Guiyang	26.58°N	106.73°E	2014	Urban	Zhou, 2016
Changzhou	31.78°N	119.92°E	2016	Suburban	Wang, 2017
Zhenjiang	32.53°N	119.6°E	2016	Urban	Wang et al., 2018
Jiangning	32.6°N	119.42°E	2016	Urban	Wang et al., 2018
Wuxi	31.93°N	120.4°E	2016	Urban	Wang et al., 2018
Xuzhou	34.46°N	117.25°E	2016	Urban	Wang et al., 2018
Hong Kong	22.21°N	114.25°E	2013	Urban	Leung et al., 2014
Urumqi	44.28°N	88.02°E	2010	Urban	Limu et al., 2013
Chongqing	29.49°N	106.48°E	2012	Urban	Chen, 2013
Chongqing	29.83°N	106.38°E	2012	Suburban	Chen, 2013
Yuxi	24.85°N	102.85°E	2014	Urban	Huang, 2016
Yichang	30.85°N	112.29°E	2015	Urban	Yang et al., 2017
Xuzhou	34.2°N	117.17°E	2012	Urban	Chen et al., 2013
Xiangtan	27.74°N	112.54°E	2015-2016	Urban	Wang et al., 2016
Wenzhou	27.98°N	120.76°E	2015	Urban	Zheng et al., 2017
Taizhou	28.5°N	121.5°E	2015-2016	Urban	Tao et al., 2017
Shijiazhuang	38.02°N	114.5°E	2015	Urban	Zhang, 2016
Shijiazhuang	37.8°N	114.53°E	2015	Suburban	Zhang, 2016
Qingdao	36.06°N	120.34°E	2013	Urban	Wang, 2015
Pingdingshan	33.71°N	113.31°E	2015	Urban	Wang, 2017
Luoyang	34.67°N	112.43°E	2015	Urban	Wang, 2017
Zhengzhou	34.8°N	113.53°E	2015	Urban	Wang, 2017
Nanjing	32.05°N	118.74°E	2013	Urban	Wang, 2015
Nanchang	28.65°N	115.83°E	2013	Urban	Wang, 2015
Mianyang	31.54°N	104.69°E	2013	Urban	Wang, 2015
Kunshan	31.11°N	120.81°E	2013	Urban	Yu et al., 2015
Lanxi	29.15°N	119.47°E	2014,2016	Urban	Zhou et al., 2018

Lhasa	29.64°N	91.18°E	2008, 2009	Urban	Ma et al., 2013b
Yinchuan	38.41°N	106.28°E	2015	Urban	Tian et al., 2017
Xi'an	34.23°N	108.82°E	2013	Urban	Wang et al., 2017
Panjin	41.17°N	122.07°E	2013	Urban	Tao, 2015
Ningbo	29.4°N	121.37°E	2009, 2010	Rural	Liu et al., 2014
Nantong	32.52°N	120.55°E	2016	Urban	Cui and Wu, 2018
Jinhua	29.12°N	119.71°E	2016	Urban	He et al., 2017
Hotan	37.1°N	79.5°E	2014	Urban	Suwubinuer et al., 2018
Hainan	18.84°N	109.5°E	2011	Suburban	Ma et al., 2013a
Harbin	45.72°N	126.73°E	2013	Urban	Li, 2015
Fuzhou	26.1°N	119.29°E	2010	Urban, Suburban	Yi et al., 2013
Ordos	36.3°N	107.18°E	2005	Urban	Wu et al., 2014
Shenzhen	22.59°N	113.97°E	2012, 2013	Urban	Sun et al., 2015
Jinan	36.66°N	117.05°E	2011	Urban	Yang, 2014
Mianyang	31.54°N	104.71°E	2014, 2015	Urban	Zhuo et al., 2017
Kunming	24.83°N	102.87°E	2014, 2015	Urban	Zhuo et al., 2017
Kunming	25.4°N	102.7°E	2013	Urban	Bi et al., 2015
Jiamusi	46.79°N	130.37°E	2012	Suburban	Li et al., 2013
Jilin	44.0°N	125.67°E	2008	Urban	Li et al., 2011
Huludao	40.0°N	119.3°E	2008	Urban	Li et al., 2011
Changchun	43.84°N	125.31°E	2008	Urban	Li et al., 2011
Qingyuan	23.68°N	113.17°E	2010	Urban	Wei et al., 2012
Xining	36.56°N	101.75°E	2007	Urban	Tang et al., 2010
Waliguan	36.3°N	100.9°E	2007	Urban	Tang et al., 2010
India	28°N	77°E	2007,2008	Urban	Singh et al., 2011
India	22°N	88°E	1992-1994	Urban	Chattopadhyay et al., 1998
Sturgeon Point	44.65°N	83.3°W	2013	Urban	IADN[a]
Sleeping Bear Dunes	44.98°N	86.18°W	2013	Urban	IADN[a]
Point Petre	44.28°N	81.65°W	2013	Urban	IADN[a]

Eagle Harbor	47.5°N	88.05°W	2013	Urban	IADN[a]
Cleveland	41.48°N	81.68°W	2013	Urban	IADN[a]
Chicago	41.86°N	87.62°W	2013	Urban	IADN[a]
Montreal-Riviere des Prairies	45.65°N	73.57°W	2013	Urban	NAPS[b]
Toronto - Gage Institute	43.65°N	79.39°W	2013	Urban	NAPS[b]
Simcoe	42.85°N	80.26°W	2013	Rural	NAPS[b]

(a) IADN: the Integrated Atmospheric Deposition Network.

(b) NAPS: the National Air Pollution Surveillance network

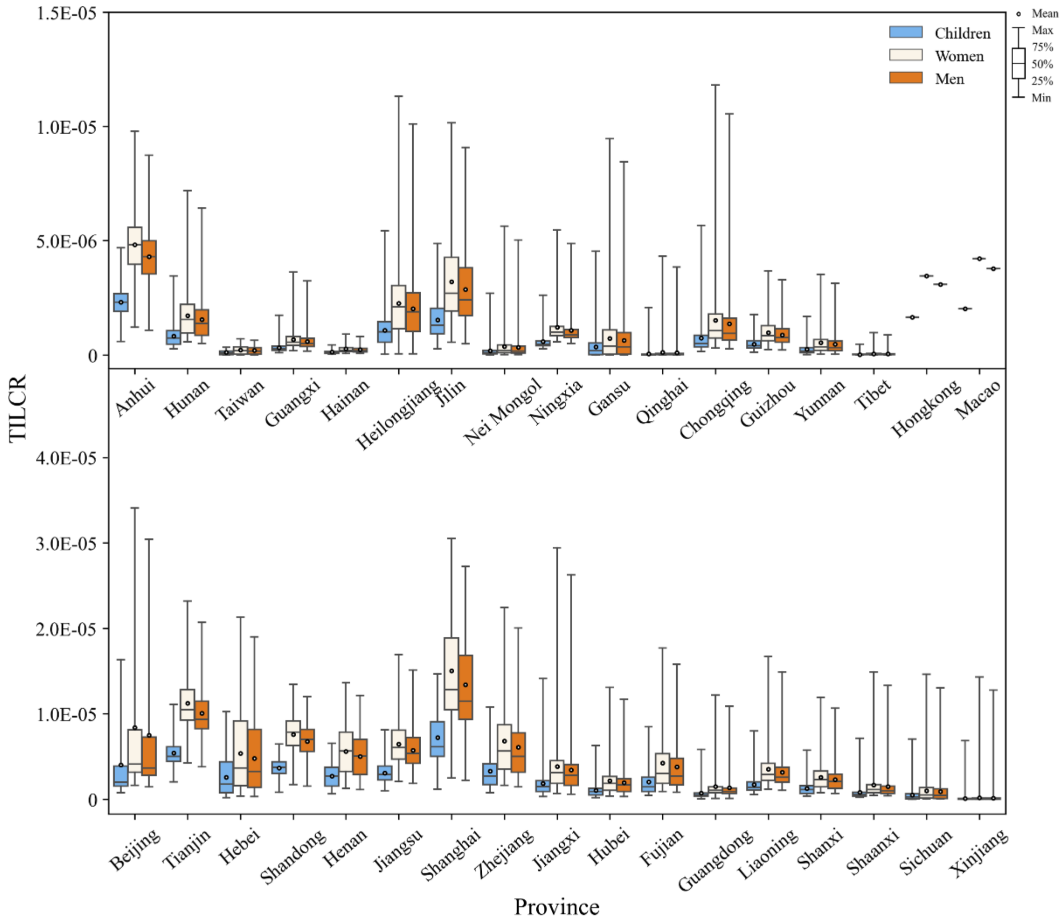

Figure S4. The TILCR values for the three age groups (Children, Women, and Men) in different provinces of China in 2018.

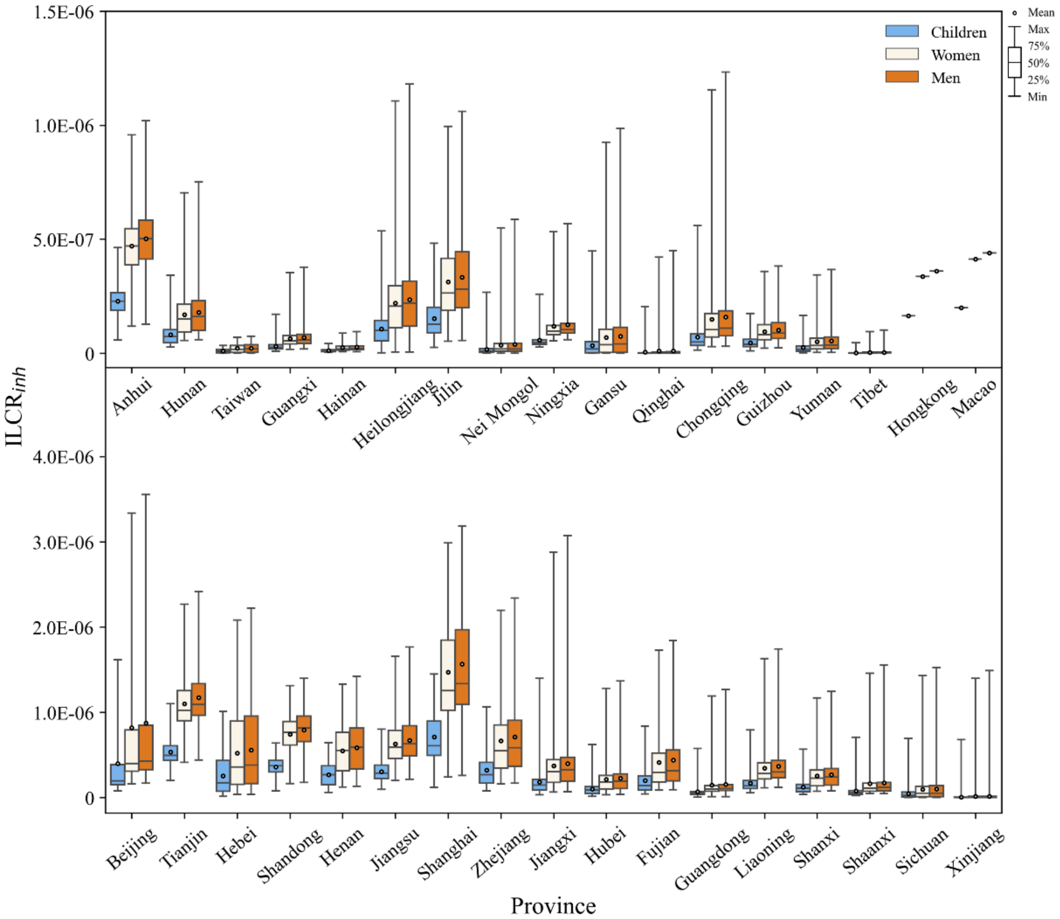

Figure S5. The ILCR$_{inh}$ values for the three groups (Children, Women, and Men) in different provinces of China in 2018.

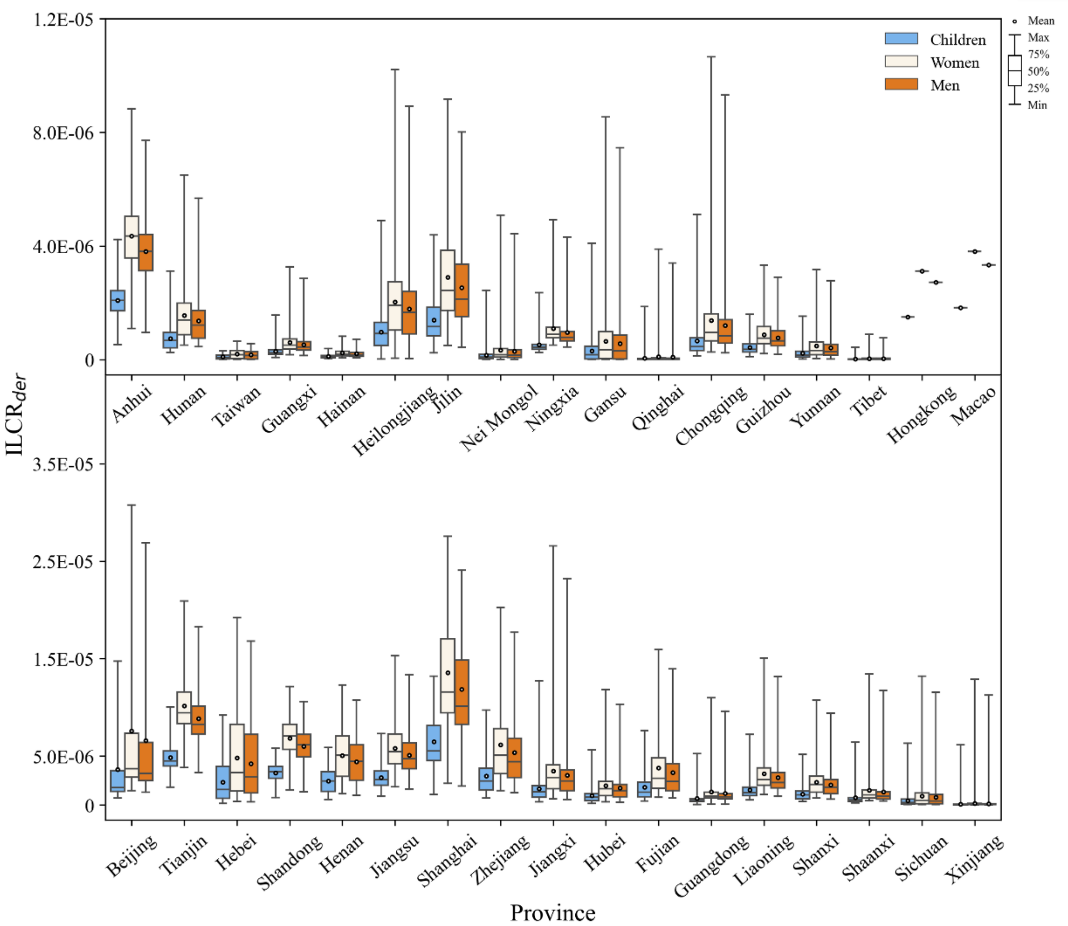

Figure S6. The ILCR$_{der}$ values for the three groups (Children, Women, and Men) in different provinces of China in 2018.

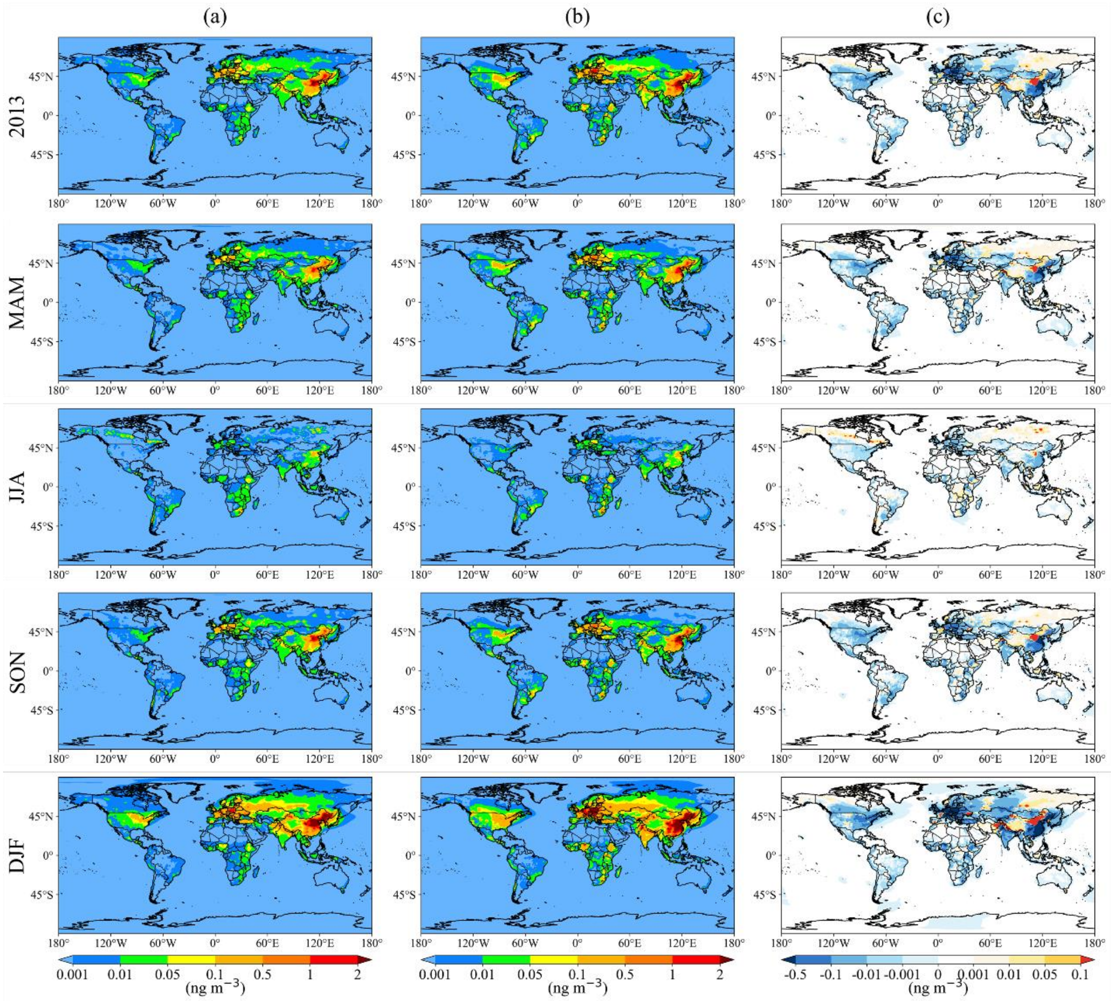

Figure S7. Spatial distributions of annual and seasonal mean BaP concentrations based on the (a) PKU and (b) EDGAR inventories in 2013. The concentration (c) difference between PKU and EDGAR, positive values indicate that the result of PKU is greater than that of EDGAR, negative values are the opposite.

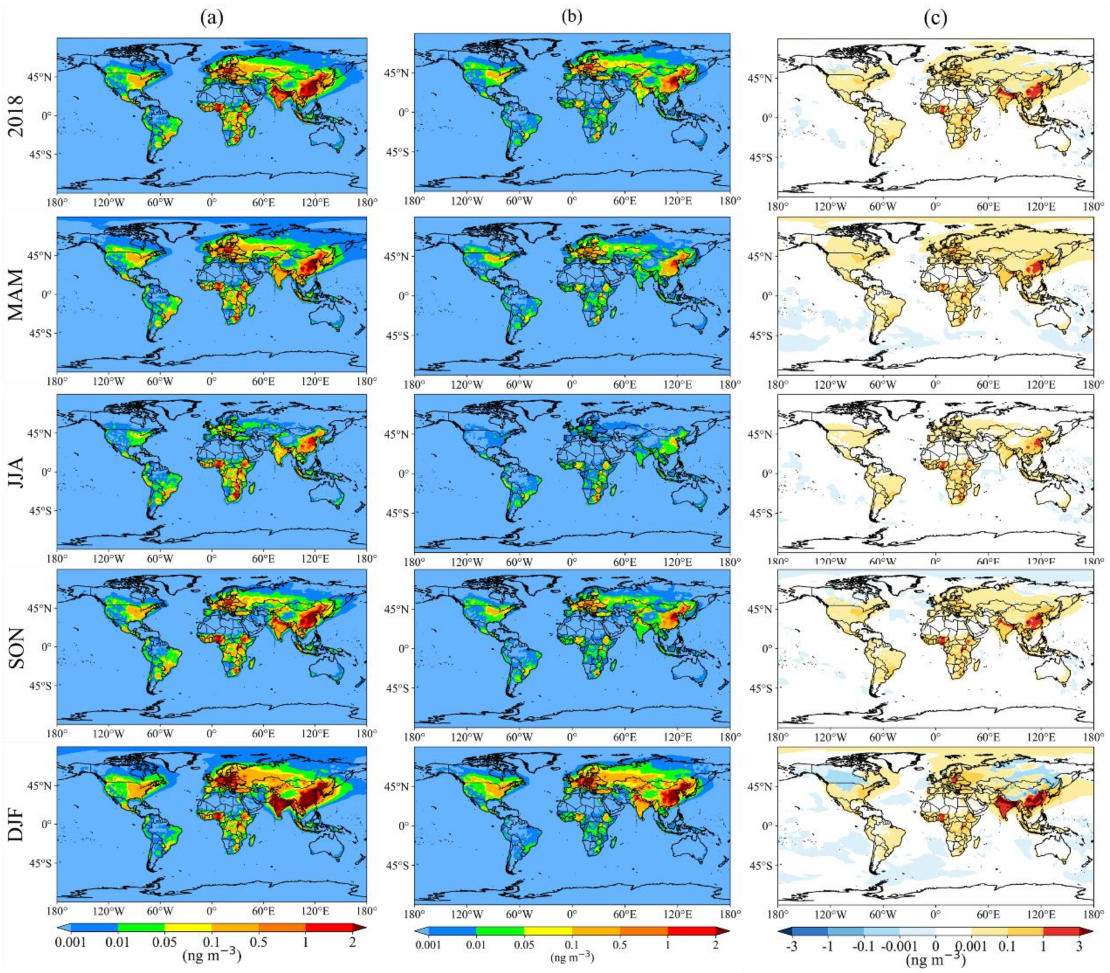

Figure S8. Spatial distributions of annual and seasonal mean BaP concentrations based on the (a) no-heterogeneous reactions and (b) ROI-T mechanisms in 2018. The concentration (c) difference between no-heterogeneous reactions and ROI-T, positive values indicate that the result of no-heterogeneous reactions is greater than that of ROI-T, negative values are the opposite.

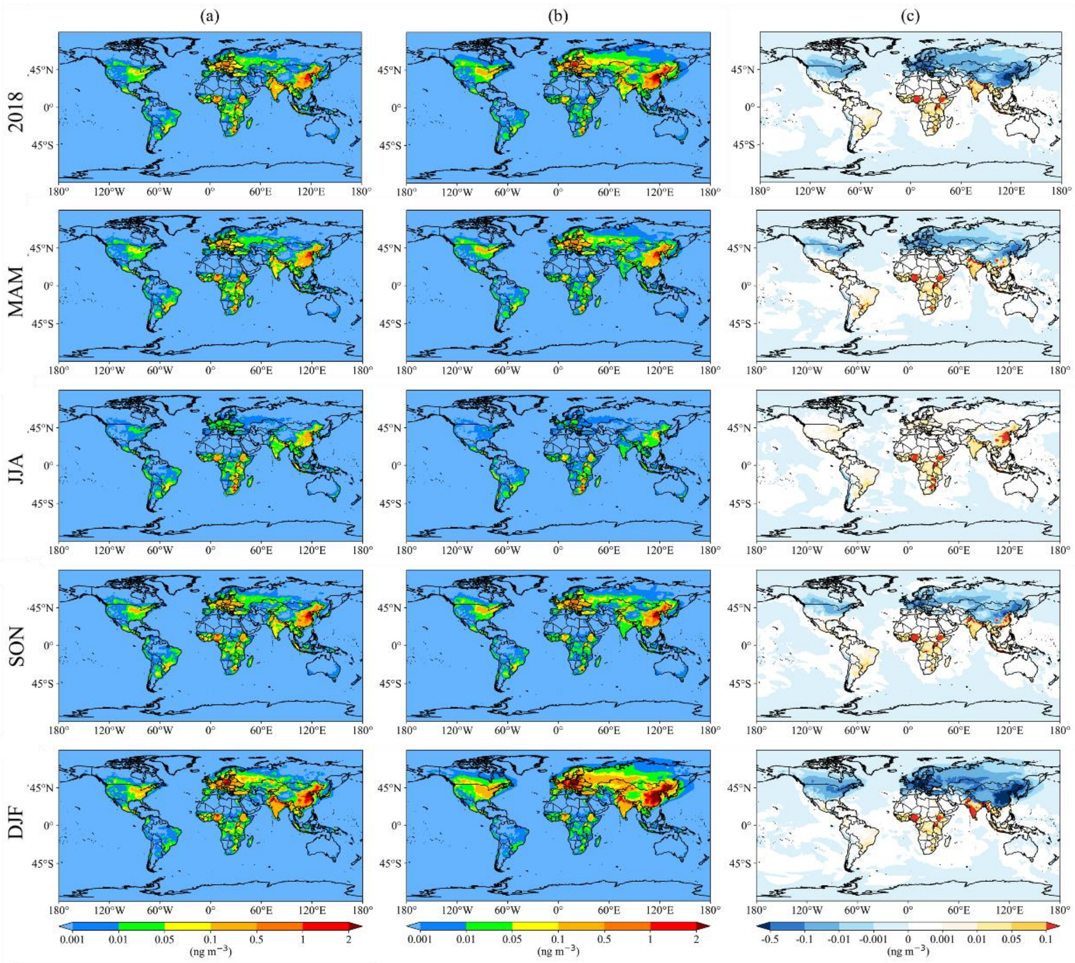

Figure S9. Spatial distributions of annual and seasonal mean BaP concentrations based on the (a) Langmuir-Hinshelwood and (b) ROI-T mechanisms in 2018. The concentration (c) difference between Langmuir-Hinshelwood and ROI-T, positive values indicate that the result of Langmuir-Hinshelwood is greater than that of ROI-T, negative values are the opposite.

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