Supporting Information for

Retene Emission from Residential Solid Fuels in China and Evaluation of Retene as a Unique Marker for Soft Wood Combustion

Guofeng SHEN [1], Shu TAO[1,]*, Siye WEI[1], Yanyan ZHANG [1], Wen WEI [1], Rong WANG [1], Bin WANG [1], Wei LI [1], Huizhong SHEN [1], Ye HUANG [1], Yifeng YANG [1], Wei WANG [1], Xilong WANG [1], Xuejun WANG [1], Staci L. MASSEY SIMONICH [2]

1. Laboratory for Earth Surface Processes, College of Urban and Environmental Sciences, Peking University, Beijing 100871, China.

2. Environmental and Molecular Toxicology and Department of Chemistry, Oregon State University, Corvallis, Oregon, USA

* Corresponding author phone and fax: 0086-10-62751938, email: taos@pku.edu.cn

There are 5 figures and 5 tables

Table S1 Measured fuel properties of Coal. The elemental and proximate analysis were conducted by the Analytical Instrumentation Center, Peking University and China National Coal Quality Supervision Testing Center.

COAL	Type	N, %	C, %	H,%	Moisture, %	Ash,%	VM %	FC %	HV, MJ/kg
BJ	honeycomb	0.39	65.5	0.84	1.26	27.41	3.99	65.94	22.42
TY-A	honeycomb	0.36	24.0	1.73	2.18	61.72	14.73	19.71	8.73
TY-B	Chunk	1.24	81.2	4.48	0.72	7.78	22.82	68.89	33.01
YL-A	Chunk	0.95	72.9	4.33	3.73	15.3	27.98	55.38	28.15
YL-B	Chunk	0.72	59.9	4.59	9.17	4.45	28.49	54.96	24.19

Table S2 Measured fuel properties of Crop residue. The elemental analysis were conducted by the Analytical Instrumentation Center, Peking University. Data shown are means of duplicated measurements.

Crop straw		C, %	H, %	N, %	O, %	Moisture,%
Horsebean	*Vicia faba*	43.10	7.39	0.86	48.65	2.84
Peanut	*Arachis hypogaea*	40.37	6.75	2.27	50.61	3.25
Soybean	*Cassia agnes*	42.33	7.55	0.86	49.26	2.79
Cotton	*Anemone vitifolia*	44.38	7.35	1.10	47.17	3.34
Rice	*Oryza sativa*	38.69	6.26	0.87	54.18	3.92
Wheat	*Triticum aestivum*	42.61	6.67	0.27	50.45	1.41
Rape	*Brassica napus*	41.25	6.99	0.45	51.31	2.22
Seasame	*Sesamum indicum*	43.20	7.34	1.73	47.73	2.46
Corn	*Zea mays*	44.46	7.08	1.54	46.92	2.53
Broomcorn	*Sorghum Moench*	45.82				6.82
Pea straw	*Pisum Linn.*	41.16				7.87

Table S3 Measured fuel properties of Wood. The elemental contents were measured by the Analytical Instrumentation Center, Peking University. Proximate analysis were conducted by Chinese Academy of Agricultural Engineering following the national standard methods.

WOOD		Density, g/cm3	ash, %	VM, %	FC, %	HHV, MJ/kg	N, %	C , %	H , %	O, %
Chinese White Poplar	*Populus tomentosa Carr.*	0.463	0.90	81.69	17.41	18.35	0.08	47.75	6.15	46.03
Elm	*Ulmus pumila L.*	0.536	1.50	78.56	19.94	18.27	0.84	46.89	5.89	46.40

Yellow Locust	*Robinia pseudoacacia L.*	1.176	0.90	78.93	20.16	18.77	1.37	45.37	6.05	47.22
Maple	*Acer mono Maxim.*	0.949	1.80	86.12	12.08	19.03	0.18	47.73	6.10	46.00
Bamboo	*Phyllostachys heterocycla(Carr.)*	0.912	0.51	84.94	14.55	18.33	0.26	48.75	5.98	45.02
Oak	*Quercus mongolica*	1.114	1.85	78.33	19.82	19.00	0.30	47.42	6.15	46.14
Willow	*Salix babylonica*	0.551	1.41	82.84	15.75	16.99	0.23	47.39	6.14	46.25
Paulownia tomentosa	*P.tomentosa (Thunb.) Steud.*	0.284	0.30	85.03	14.67	16.00	0.13	48.76	6.11	45.02
Toon	*Ailanthus altissima*	0.734	1.49	82.94	15.57	17.28	0.18	47.71	6.13	45.99
White Birch	*Betula platyphylla Suk*	0.798	0.39	87.45	12.17	20.22	0.21	48.33	6.20	45.28
Ribbed Birch	*Betula dahurica Pall.*	1.059	5.05	84.08	10.87	18.14	0.19	48.41	6.22	45.19
Paulownia elongata	*P. elongata S. Y. Hu*	0.763	0.34	81.68	17.98	19.33	0.08	48.85	6.09	44.98
Black (Italian) Poplar	*Populus nigra L.*	1.080	1.53	77.11	21.36	18.93	0.32	47.45	6.06	46.18
China Aspen	*Populus adenopoda Maxim.*	0.867	1.45	81.89	16.67	19.33	0.38	47.42	6.08	46.14
Chinaberry	*Melia azedarach*	0.654	2.07	76.95	20.98	17.67	0.46	48.72	5.93	44.89
Jujube	*Ziziphus jujuba Mill.*	0.805	0.88	79.81	19.30	18.61	0.59	47.19	6.03	46.20
Persimmon	*Diospyros kaki Thunb.*	0.710	1.71	79.56	18.72	18.05	0.30	46.52	5.94	47.25
Mulberry	*Morus alba L.*	0.909	1.37	77.13	21.50	18.73	0.20	48.27	6.01	45.52
Peach	*Prunus persica*	0.770	3.81	77.79	18.40	19.35	0.26	48.10	6.01	45.65
Lespedeza	*Leapedeza bicolor. Turcz*		4.60	81.08	14.32			48.59		
Buxus sinica	*Buxus sinica (Rehd. et Wils.) Cheng*		5.84	78.36	15.80			48.19		
Holly	*Buxus megistophylla Lévl*		8.56	77.58	13.86			45.85		
Fir	*Cunninghamia lanceolata*	0.427	0.42	82.94	16.64	18.61	0.13	49.83	6.18	43.87
Larch	*Larix gmelini (Rupr.) Rupr.*	0.634	0.46	82.10	17.44	19.22	0.14	48.23	6.20	45.44
Water Chinese fir	*Metasequoia glyptostroboides*	0.410	0.71	79.91	19.38	19.49	0.29	49.42	6.07	44.22
Cypress	*Cupressus funebris Endl.*	0.667	1.47	76.60	21.93	20.02	0.36	50.13	6.02	43.49
Chinese Pine	*Pinus tabulaeformis Carr.*	0.443	0.25	84.77	14.98	18.51	0.18	49.10	6.32	44.41

Table S4 Measured combustion/sampling durations, temperatures, and calculated burning rates (R) and modified combustion efficiencies (MCE).

COAL	Duration, min	Temperature, °C	MCE, %	R, g/min
BJ	40-50		88.0±0.0	12.7±1.7
TY-A	144-167		91.3±5.1	3.99±0.35
TY-B	216-310		90.4±4.6	4.37±1.13
YL-A	132-166		82.8±2.0	4.03±0.60
YL-B	205-274		94.1±0.7	2.86±0.44
Crop Residue				
Horsebean	16-19	450-658	92.4±0.5	18.3±1.5
Peanut	21	400-650	88.70	19.9
Soybean	20-22	436-679	95.0±0.1	26.9±1.4
Cotton	26-29	525-756	95.5±0.2	24.3±1.2
Rice	15-17	450-660	85.8±0.1	33.9±1.6
Wheat	14-17	495-650	91.2±0.2	12.5±1.4
Rape	10-14	600-680	89.3±1.1	20.2±3.4
Seasame	15-17	500-650	94.2±4.0	13.4±1.7
Corn	24-26	480-750	93.9±1.6	17.9±4.5
Broomcorn	20-24	440-620	96.6±0.0	23.4±7.1
Pea straw	23-24	400-530	96.2±2.5	23.9±0.0
WOOD				
Chinese White Poplar	32-52	590-680	94.7±0.9	24.5±2.0
Elm	28-35	525-776	95.6±0.1	22.5±2.2
Yellow Locust	48-54	400-700	93.7±0.1	46.6±5.9
Maple	40-46	350-580	95.7±0.2	43.4±3.1
Bamboo	25-31	337-720	95.2±0.9	33.4±4.0
Oak	32-37	350-483	95.0±0.4	31.3±2.8
Willow	43-47	610-737	95.1±0.2	28.7±1.3
Paulownia tomentosa	35-37	420-690	94.8±0.3	28.5±0.8
Toon	35-45	250-743	95.4±0.3	25.6±3.4
White Birch	36-41	533-710	93.6±0.7	27.0±1.5
Ribbed Birch	53-54	520-696	95.6±0.3	44.7±0.5
Paulownia elongata	35-50	200-383	88.6±0.6	30.8±6.5
Black (Italian) Poplar	40-44	240-450	93.5±0.0	41.0±0.0
China Aspen	54-55	250-400	94.3±0.6	35.8±2.4
Chinaberry	37-42	250-570	92.2±1.2	32.5±2.3
Jujube	42-45	280-680	92.9±0.3	26.1±1.0
Persimmon	55-57	200-710	93.5±0.1	22.1±0.0
Mulberry	49-58	370-494	93.9±0.6	20.6±1.4
Peach	39-44	242-700	94.6±0.1	25.5±1.7
Lespedeza	20-27	370-780	94.4±0.1	53.0±8.5
Buxus sinica	29-31	430-657	94.8±0.5	33.1±1.0
Holly	31-47	375-786	95.8±0.7	25.6±3.8
Fir	32-35	453-620	96.0±0.3	29.5±1.5
Larch	34-35	300-720	95.8±0.3	28.5±0.5
Water Chinese fir	30-32	320-515	96.2±0.0	35.4±0.7
Cypress	33-50	230-530	93.5±0.8	26.6±5.6
Chinese Pine	47-66	330-738	94.1±1.6	36.9±6.2

Table S5 Emission Factors of RET and ratios of RET/PHE for various solid fuels measured in this study and reported in the literature.

Fuel Type	Combustion facility	EF, mg/kg	RET/PHE	Reference
Softwood				
pine wood	FP	0.70		*Simoneit et al., [1]*
pine wood	FP	9.90	0.60	*Schauer et al., [2]*
pine wood	FP	0.68	1.45	*Rogge et al., [3]*
pine	FP	0.49		*Gullett et al., [4]*
pine (Ponderosa pine, pinion pine)	FP	1.79	0.17	*McDonald et al., [5]*
penderosa pine	FP	18.9	66.04	*Fine et al., [6]*
pinyon pine	FP	43.9	40.00	*Fine et al., [6]*
esatern white pine	FP	45.9	34.94	*Fine et al., [7]*
loblolly pine	FP	16.8	11.33	*Fine et al., [8]*
slash pine	FP	9.01	48.27	*Fine et al., [8]*
eastern hemlock	FP	6.31	22.82	*Fine et al., [7]*
white spruce	FP	6.52	22.81	*Fine et al., [6]*
balsam fir	FP	3.79	10.16	*Fine et al., [7]*
douglas fir	FP	+		*Fine et al., [6]*
apache pine		25.00	12.06	*Oros et al., [9]*
eastern white pine		25.339	6.04	*Oros et al., [9]*
lodgepole pine		4.165	2.82	*Oros et al., [9]*
montezuma pine		25.043	3.26	*Oros et al., [9]*
pacific pine		7.797	10.49	*Oros et al., [9]*
western white pine		34.717	17.35	*Oros et al., [9]*
california redwood		0.274	0.43	*Oros et al., [9]*
douglas fir		6.51	4.40	*Oros et al., [9]*
moutain hemlock		0.573	0.07	*Oros et al., [9]*
noble fir		0.963	2.43	*Oros et al., [9]*
pacific silver fir		3.842	0.51	*Oros et al., [9]*
sitka spruce		2.634	3.68	*Oros et al., [9]*
pinus pinaster	WS	4.18	8.17	*Goncalves et al., [10]*
loblolly pine	WS, no catalytic	3.39	6.64	*Fine et al., [11]*
douglas fir	WS, no catalytic	1.70	2.06	*Fine et al., [11]*
Pine	WS	0.84$^{\#}$	6.46	*Bari et al., [12]*
spruce	WS, 0.4 kg/h	1113$^{\#}$	1.64	*Ramdahl et al., [13]*
spruce	WS, 3.1 kg/h	16$^{\#}$	0.19	*Ramdahl et al., [13]*
spruce	boiler, 40kg/h	1420$^{\#}$	0.29	*Ramdahl et al., [13]*
spruce	boiler, 40kg/h	360$^{\#}$	0.11	*Ramdahl et al., [13]*
pine wood	burning furance	82$^{\#}$	1.46	*Kozinski et al., [14]*
pine	WS-hot	15.4*	148.08	*Goncalves et al., [15]*
pine	WS-cold	4.12*	20.70	*Goncalves et al., [15]*
pine	FP-fot	1.54*	39.59	*Goncalves et al., [15]*
pine	FP-cold	6.43*	17.33	*Goncalves et al., [15]*
douglas fir	WS, yes catalytic	3.52	4.34	*Fine et al., [11]*
Fir	Residential Stove	0.07	0.04	*this study*
Larch	Residential Stove	0.29	0.27	*this study*
Water Chinese fir	Residential Stove	0.13	0.07	*this study*
Cypress	Residential Stove	0.14	0.10	*this study*
Chinese pine	Residential Stove	0.34	0.28	*this study*
Hardwood				

oak	FP	0.10		*Simoneit et al., [1]*
oak	FP	2.33	0.25	*Schauer et al., [2]*
eucalyptus	FP	0.15	0.02	*Schauer et al., [2]*
oak	FP	0.11	0.37	*Rogge et al., [3]*
oak mixed cottonwood birch aspen	FP	0.50	0.03	*McDonald et al., [5]*
oak	FP	ND		*Gullett et al., [4]*
white oak_hw	FP	+		*Fine et al., [6]*
sugar maple	FP	+		*Fine et al., [6]*
black oak	FP	+		*Fine et al., [6]*
american beech	FP	+		*Fine et al., [6]*
black cherry	FP	+		*Fine et al., [6]*
quaking aspen	FP	+		*Fine et al., [6]*
red maple	FP	+		*Fine et al., [7]*
nirthern red oak	FP	+		*Fine et al., [7]*
paper birch	FP	+		*Fine et al., [7]*
yellow polar	FP	+		*Fine et al., [8]*
white ash	FP	+		*Fine et al., [8]*
sweetgum	FP	+		*Fine et al., [8]*
mockernut hickory	FP	+		*Fine et al., [8]*
oak	WS	ND		*Gullett et al., [4]*
Eucalyptus	WS	0.09	3.84	*Goncalves et al., [10]*
quercus suber_cork oak	WS	0.17	1.19	*Goncalves et al., [10]*
acacia lognifolia_Acacia	WS	0.04	22.37	*Goncalves et al., [10]*
birch	WS	<0.1		*Hedberg et al., [16]*
oak mixed cottonwood birch aspen	WS	0.02	0.00	*McDonald et al., [5]*
red maple	WS, no catalytic	0.00	0.01	*Fine et al., [11]*
white oak	WS, no catalytic	0.03	0.09	*Fine et al., [11]*
white oak	WS, yes catalytic	0.01	0.04	*Fine et al., [11]*
sugar maple	WS, no catalytic	0.01	0.04	*Fine et al., [11]*
Beech	WS	$0.17^{\#}$	4.25	*Bari et al., [12]*
golden wattle	WS-hot	0.16*	0.95	*Goncalves et al., [15]*
golden wattle	WS-cold	0.44*	1.92	*Goncalves et al., [15]*
golden wattle	FP-fot	0.28*	4.07	*Goncalves et al., [15]*
golden wattle	FP-cold	0.049*	0.28	*Goncalves et al., [15]*
oak	WS-hot	0.15*	1.31	*Goncalves et al., [15]*
oak	WS-cold	0.36*	0.90	*Goncalves et al., [15]*
oak	FP-hot	0.023*	0.04	*Goncalves et al., [15]*
oak	FP-cold	0.035*	0.31	*Goncalves et al., [15]*
eucalypt	WS-hot	0.10*	1.45	*Goncalves et al., [15]*
eucalypt	WS-cold	0.12*	0.41	*Goncalves et al., [15]*
eucalypt	FP-cold	0.084*	0.95	*Goncalves et al., [15]*
Chinese white poplar	Residential Stove	0.07	0.04	*this study*
Elm	Residential Stove	0.04	0.02	*this study*
Yellow Locust	Residential Stove	0.07	0.09	*this study*
Maple	Residential Stove	0.06	0.04	*this study*
bamboo	Residential Stove	0.08	0.02	*this study*
OAK	Residential Stove	0.13	0.12	*this study*
Willow	Residential Stove	0.09	0.16	*this study*
Paulownia tomentosa	Residential Stove	0.16	0.17	*this study*
Toon	Residential Stove	0.05	0.06	*this study*

white birch	Residential Stove	0.08	0.05	*this study*
Lespedeza	Residential Stove	0.04	0.00	*this study*
Holly	Residential Stove	0.09	0.01	*this study*
Buxus sinica	Residential Stove	0.04	0.01	*this study*
Ribbed birch	Residential Stove	0.02	0.01	*this study*
Paulownia Elongata	Residential Stove	0.05	0.02	*this study*
Black poplar	Residential Stove	0.15	0.04	*this study*
China Aspen	Residential Stove	0.02	0.01	*this study*
Chinaberry	Residential Stove	0.15	0.06	*this study*
Jujube tree	Residential Stove	0.04	0.02	*this study*
Persimmon tree	Residential Stove	0.08	0.04	*this study*
Mulberry tree	Residential Stove	0.06	0.02	*this study*
Peach tree	Residential Stove	0.06	0.03	*this study*
Crop Residue				
rice	simulated open burning	0.90	3.26	*Hays et al., [17]*
wheat	simulated open burning	0.01	0.48	*Hays et al., [17]*
Broomcorn	Residential Stove	0.10	0.05	*this study*
Pea straw	Residential Stove	0.08	0.02	*this study*
Horsebean	Residential Stove	0.10	0.01	*this study*
Peanut straw	Residential Stove	0.13	0.02	*this study*
Soybean straw	Residential Stove	0.05	0.01	*this study*
Cotton stalk	Residential Stove	0.05	0.02	*this study*
Rice straw	Residential Stove	0.12	0.01	*this study*
Wheat straw	Residential Stove	0.21	0.01	*this study*
Rape straw	Residential Stove	0.37	0.02	*this study*
Seasame straw	Residential Stove	0.17	0.02	*this study*
Corn straw	Residential Stove	0.18	0.03	*this study*
Coal				
Lignite		101.00	0.78	*Oros and Simoneit [18]*
Sub-bituminous		282.00	1.86	*Oros and Simoneit [18]*
Briquette-anthricate	Residential Stove	2.17	1.76	*this study*
briquette-bituminous	Residential Stove	3.68	1.29	*this study*
Chunk-bituminous	Residential Stove	30.15	1.45	*this study*
Chunk-bituminous	Residential Stove	186.90	6.10	*this study*
Chunk-bituminous	Residential Stove	30.31	3.07	*this study*
Synthetic logs				
synthetic logs (pine mountain)	FP	2.72	5.91	*Rogge et al., [3]*
synthetic log	FP	0.39	0.05	*McDonald et al., [5]*
artificial log (wax and sawdust)	FP	10.96		*Gullett et al., [4]*

[#] unit: ug/m^3; * unit: mg/g OC ; ND: not detected; +: detected but not quantified
FP: fireplace, WD: woodstove,

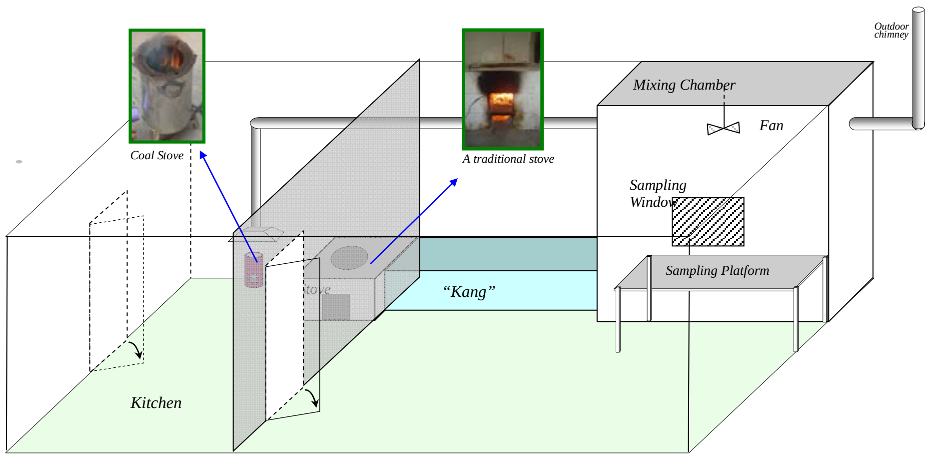


Figure S1. Layout of the kitchen and stoves in the combustion emission experiments.

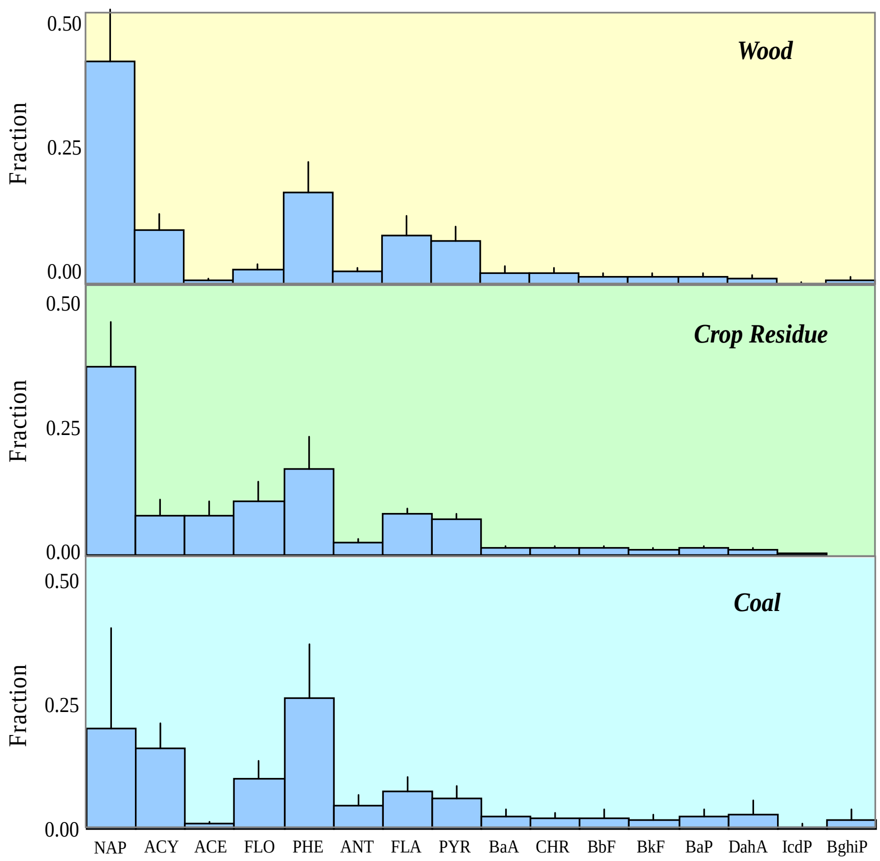


Figure S2. Composition profiles of 16 EPA priority PAHs in indoor air from residential crop residue, wood and coal combustion [19-20].

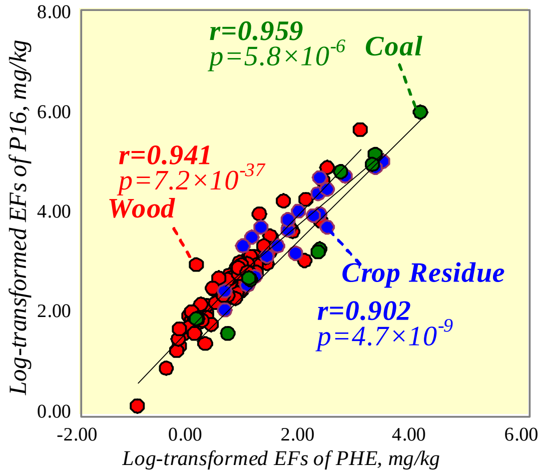
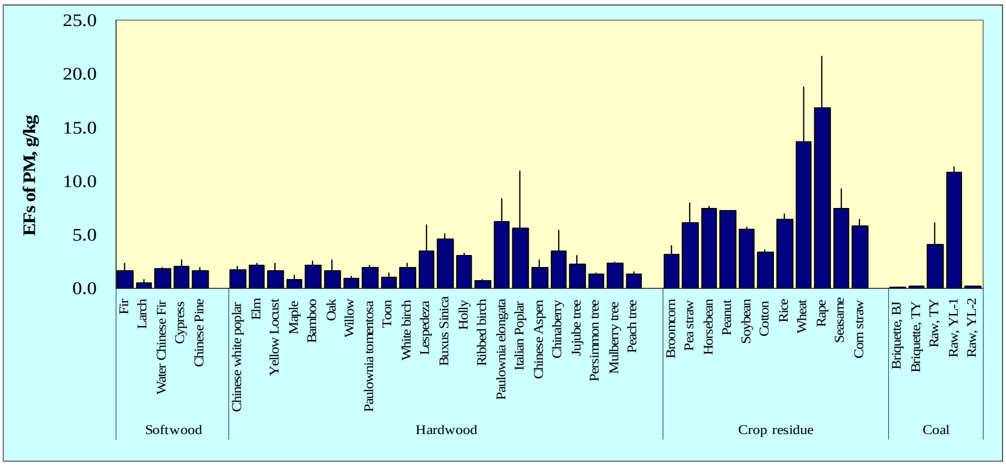


Figure S3. Correlation between the log-transformed EFs of PHE and those of total 16 EPA priority PAHs (P16) from residential wood, crop residue, and coal combustion.



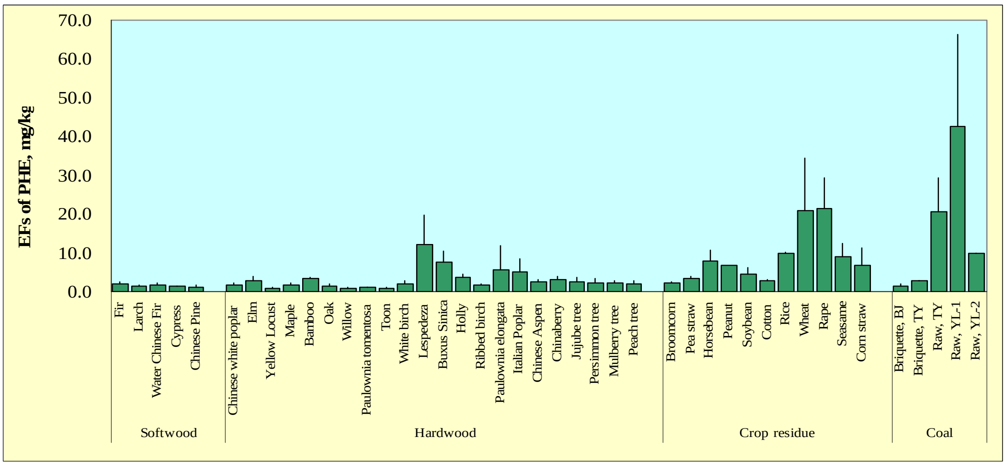


Figure S4. The measured PM and PHE EFs in dry basis for wood, crop residue, and coal combustions. The results are presented in arithmetic means and standard deviations[19-20].

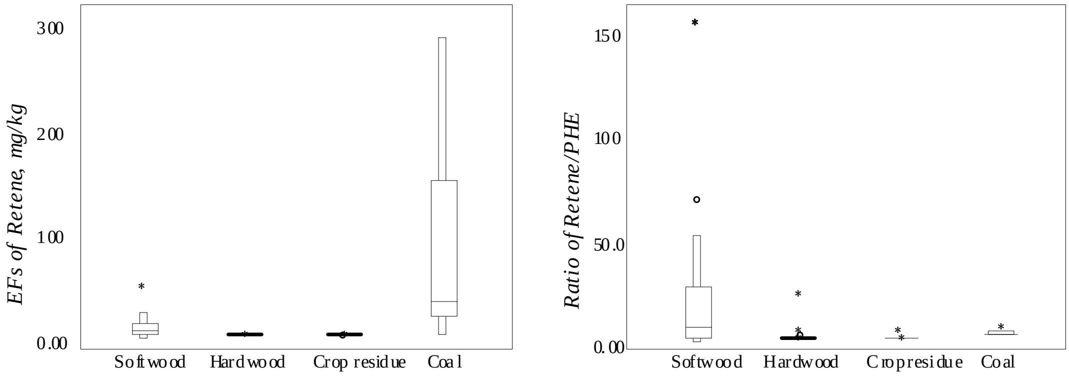


Figure S5. EF_{RET} (mg/kg, dry basis) and ratios of EF_{RET}/EF_{PHE} for simultaneously measured RET and PHE from softwood, hardwood, crop residue, and coal combustion. Data used include those measured in this study and those collected from the literature (Table S5).

References

(1) Simoneit, B. R. T.; Rogge, W. F.; Mazurek, M. A.; Standley, L. J. Hildemann, L. M.; Cass, G. R. Lignin pyrolysis products, lignans, and resin acids as specific tracers of plant classes in emissions from biomass combustion. *Environ. Sci. Technol.* **1993,** *27*, 2533-2541.

(2) Schauer, J. J.; Kleeman, M. J.; Cass, G. R.; Simoneit, B. R. T. Measurement of emissions from air pollution sources. 3. C_1-C_{22} organic compounds from fireplace combustion of wood. *Environ. Sci. Technol.* **2001,** *35*, 1716-1728.

(3) Rogge, W. F.; Hildemann, L. M.; Mazurek, M. A.; Cass, G. R.; Simoneit, B. R. T. Sources of fine organic aerosol. 9. pine, oak and synthetic log combustion in residential fireplaces. *Environ. Sci. Technol.* **1998,** *32*, 13-22.

(4) Gullett, B. K.; Touati, A.; Hays, M. D. PCDD/F, PCB, HxCBz, PAH, and PM emission factors for fireplaces and woodstove combustion in the San Francisco Bay region. *Environ. Sci. Technol.* **2003,** *37*, 1758-1765.

(5) McDonald, J. D.; Zielinska, B.; Fugita, E. M.; Saebiel, J. C.; Chow, J. C.; Watson, J. G. Fine particle and gaseous emission rates from residential wood combustion. *Environ. Sci. Technol.* **2000,** *34*, 2080-2091.

(6) Fine, P. M.; Cass, G. R.; Simoneit, B. R. T. Chemical characterization of fine particle emissions from fireplace combustion of wood types grown in the Midwestern and Western United States. *Environ. Eng. Sci.* **2004,** *21*, 387-409.

(7) Fine, P. M.; Cass, G. R.; Simoneit, B. R. T. Chemical characterization of fine particle emissions from fireplace combustion of woods grown in the Northeastern United States. *Environ. Sci. Technol.* **2001,** *35*, 2665-2675.

(8) Fine, P. M.; Cass, G. R.; Simoneit, B. R. T. Chemical characterization of fine particle emissions from fireplace combustion of woods grown in the Southern United States. *Environ. Sci. Technol.* **2002,** *36*, 1442-1451.

(9) Oros, D. R.; Simoneit, B. R. T. Identification and emission factors of molecular tracers in organic aerosols from biomass burning Part 1. temperate climate conifers. *Applied Geochemistry* **2001,** *16*, 1513-1544.

(10) Goncalves, C.; Alves, C.; Evtyugina, M.; Mirante, F.; Pio, C.; Caseiro, A.; Schmidl, C.; Bauer, H.; Carvalho, F. Characterisation of PM10 emissions from woodstove combustion of common woods grown in Portugal. *Atmos. Environ.* **2010,** *44*, 4474-4480.

(11) Fine, P. M.; Cass, G. R.; Simoneit, B. R. T. Chemical characterization of fine particle emissions from fireplace combustion of wood stove combustion of prevalent United States tree species. *Environ. Eng. Sci.* **2004,** *21*, 705-721.

(12) Bari, M. A.; Baumbach, G.; Kuch, B.; Scheffknecht, G. Wood smoke as a source of particle-phase organic compounds in residential areas. *Atmos. Environ.* **2009,** *43*, 4722-4732.

(13) Ramdahl, T. Retene – a molecular marker of wood combustion in ambient air. *Nature* **1983,** *306*, 580-582.

(14) Kozinski, J. A.; Saade, R. Effect of biomass burning on the formation of soot particles and heavy hydrocarbons. An experimental study. *Fuel* **1998,** *77*, 225-237.
(15) Goncalves, C.; Alves, C.; Fernandes, A. P.; Monteiro, C.; Tarelho, L.; Evtyugina, M.; Pio, C. Organic compounds in PM2.5 emitted from fireplace and woodstove combustion of typical Portuguese wood species. *Atmos. Environ.* **2011,** *45,* 4533-4545.
(16) Hedberg, E.; Kristensson, A.; Ohlsson, M.; Johansson, C.; Johansson, P.; Swietlicki, E.; Vesely, V.; Wideqvist, U.; Westerholm, R. Chemical and physical characterization of emissions from birch wood combustion in a wood stove. *Atmos. Environ.* **2002,** *36,* 4823-4837.
(17) Hays, M. D.; Fine, P. M.; Geron, C. D.; Kleeman, M. J.; Gullett, B. K. Open burning of agricultural biomass: physical and chemical properties of particle-phase emissions. *Atmos. Environ.* **2005,** *39,* 6747-6764.
(18) Oros, D. R.; Simoneit, B. R. T. Identification and emission rates of molecular tracers in coal smoke particulate matter. *Fuel* **2000,** *79,* 515-536.
(19) Shen, G.; Wang, W.; Yang, Y.; Ding, J.; Xue, M.; Min, Y.; Zhu, C.; Shen, H.; Li, W.; Wang, B.; Wang, R.; Wang, X.; Tao, S.; Russell, A. G. Emissions of PAHs from indoor crop residue burning in a typical rural stove: emission factors, size distributions and gas-particle partitioning. *Environ. Sci. Technol.* **2011,** *45*, 1206-1212.
(20) Shen, G.; Wang, W.; Yang, Y.; Zhu, C.; Min, Y.; Xue, M.; Ding, J.; Li, W.; Wang, B.; Shen, H.; Wang, R.; Wang, X.; Tao, S. Emission factors and particulate matter size distribution of polycyclic aromatic hydrocarbons from residential coal combustions in rural Northern China. *Atmos. Environ.* **2010,** *44,* 5237-5243.