Supplemental Materials

Characterization of VOCs during Nonheating and Heating Periods in the Typical Suburban Area of Beijing, China: Sources and Health Assessment

Bi'an Zhou [1,2], Tianyi Zhao [1,2], Jian Ma [1,2], Yuanxun Zhang [1,2,3], Lijia Zhang [4], Peng Huo [1,2] and Yang Zhang [1,2,3,*]

[1] College of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China; zhoubian19@mails.ucas.ac.cn (B.Z.); zhaotianyi19@mails.ucas.ac.cn (T.Z.); majian19@mails.ucas.ac.cn (J.M.); yxzhang@ucas.edu.cn (Y.Z.); huopeng@ucas.ac.cn (P.H.)
[2] Beijing Yanshan Earth Critical Zone National Research Station, Chinese Academy of Sciences,
Beijing 101400, China
[3] National Engineering Laboratory for VOCs Pollution Control Material & Technology, Beijing 101400, China
[4] Resource and Environmental Branch, China National Institute of Standardization, Haidian District,
Beijing 100191, China; zhanglij@cnis.ac.cn (L.Z.)
* Correspondence: zhangyang@ucas.ac.cn (Y.Z.); Tel.: +86-10-6967-2963

Table S1. List of MDL, R^2 and RSD of VOCs species.

Groups	Species	MDL (ppbv)	R^2	RSD (%)
Alkanes				
	Ethane	0.025	0.996	12.25
	Propane	0.034	0.999	7.69
	Isobutane	0.015	0.999	5.96
	n-Butane	0.006	0.999	5.27
	Isopentane	0.013	0.998	5.81
	n-Pentane	0.013	0.996	7.46
	2,2-Dimethylbutane	0.009	0.997	5.62
	2,3-Dimethylbutane	0.009	0.998	5.30
	2-Methylpentane	0.011	0.999	4.61
	Cyclopentane	0.016	0.997	4.78
	3-Methylpentane	0.006	0.998	4.49
	n-Hexane	0.005	0.998	4.28
	2,4-Dimethylpentane	0.012	0.996	4.95
	Methylcyclopentane	0.009	0.998	5.82
	2-Methylhexane	0.013	0.997	7.36
	Cyclohexane	0.010	0.997	7.47
	2,3-Dimethylpentane	0.016	0.995	5.02
	3-Methylhexane	0.010	0.996	4.77
	2,2,4-Trimethylpentane	0.012	0.997	4.16
	n-Heptane	0.012	0.997	6.50
	Methylcyclohexane	0.013	0.998	3.95
	2,3,4-Trimethylpentane	0.014	0.998	4.80
	2-Methylheptane	0.018	0.999	4.91
	3-Methylheptane	0.009	0.999	4.62
	n-Octane	0.014	0.999	4.35
	n-Nonane	0.006	0.996	6.38
	n-Decane	0.014	0.995	10.95
	n-Undecane	0.007	0.996	5.47
	n-Dodecane	0.009	0.996	10.30
Alkenes				
	Ethylene	0.026	1.000	3.20
	Propylene	0.024	0.999	5.50
	1-Butene	0.023	1.000	4.85
	1,3-Butadiene	0.013	1.000	4.89
	trans-2-Butene	0.018	0.998	6.97
	cis-2-Butene	0.015	0.997	6.50
	1-Pentene	0.022	0.996	10.31
	trans-2-Pentene	0.012	0.995	11.19
	cis-2-Pentene	0.015	0.995	5.62
	Isoprene	0.014	0.995	6.41
	1-Hexene	0.009	0.998	4.78
Alkynes				
	Acetylene	0.020	0.999	4.61
Halohydrocarbons				
	Freon-11	0.016	0.999	5.45
	Freon-12	0.010	0.999	5.42

	Freon-113	0.008	0.997	6.96
	Freon-114	0.019	0.999	5.51
	Chloromethane	0.020	0.999	8.26
	Vinyl chloride	0.018	0.999	5.34
	Bromomethane	0.012	0.997	6.12
	Chloroethane	0.020	0.999	5.05
	Methylene chloride	0.015	0.999	7.07
	Trichloromethane	0.012	0.997	6.21
	Carbon tetrachloride	0.018	0.999	6.99
	1,1-Dichlorethene	0.020	0.998	4.79
	1,1-Dichloroethane	0.006	0.997	5.53
	trans-1,2-Dichloroethene	0.009	0.997	5.31
	cis-1,2-Dichloroethylene	0.015	0.997	5.83
	Trichloroethene	0.010	0.998	4.73
	Tetrachloroethene	0.010	0.999	4.52
	1,1,1-Trichloroethane	0.021	0.998	7.46
	1,2-Dichloroethane	0.011	0.999	8.99
	1,2-Dichloropropane	0.021	0.998	4.66
	Dibromochloromethane	0.018	0.999	3.99
	Bromodichloromethane	0.011	0.999	4.26
	trans-1,3-Dichloropropene	0.013	0.999	3.27
	cis-1,3-Dichloropropene	0.019	1.000	2.87
	1,1,2-Trichloroethane	0.009	0.996	16.43
	Ethylene dibromide	0.007	0.999	3.22
	Chlorobenzene	0.009	0.999	2.71
	Bromoform	0.008	0.997	10.73
	1,1,2,2-Tetrachloroethane	0.010	0.998	4.22
	1,3-Dichlorobenzene	0.010	0.998	4.20
	1,4-Dichlorobenzene	0.010	0.999	3.52
	Benzyl chloride	0.011	0.997	5.09
	1,2-Dichlorobenzene	0.013	0.999	3.08
	1,2,4-Trichlorobenzene	0.014	0.997	7.08
	Hexachloro-1,3-butadiene	0.007	0.995	17.19
Aromatics				
	Benzene	0.008	0.998	6.95
	Toluene	0.011	0.997	4.79
	Ethylbenzene	0.009	0.998	6.45
	m/p-Xylene	0.009	0.997	10.71
	o-Xylene	0.007	0.996	9.02
	Styrene	0.011	0.996	4.90
	Isopropylbenzene	0.013	0.996	5.97
	n-Propylbenzene	0.012	0.998	3.86
	p-Ethyltoluene	0.013	0.997	5.36
	m-Ethyltoluene	0.012	0.997	7.82
	1,3,5-Trimethylbenzene	0.008	0.998	11.76
	o-Ethyltoluene	0.010	0.995	6.47
	1,2,4-Trimethylbenzene	0.008	0.995	6.19
	1,2,3-Trimethylbenzene	0.007	0.996	4.86
	m-Diethylbenzene	0.013	0.997	5.03
	p-Diethylbenzene	0.016	0.998	4.08

	Naphthalene	0.010	0.997	9.81
OVOCs				
	Acetaldehyde	0.032	0.999	11.87
	Acrolein	0.019	0.999	3.41
	Propanal	0.013	0.998	12.60
	Acetone	0.008	0.999	9.17
	2-Propanol	0.021	0.999	5.41
	MTBE	0.010	0.998	4.33
	Methacrolein	0.022	0.998	4.52
	Vinyl acetate	0.009	0.997	4.17
	2-Butanone	0.012	0.997	5.92
	Butanal	0.024	0.997	5.71
	Ethyl acetate	0.016	0.999	3.58
	Tetrahydrofuran	0.022	0.998	6.75
	4-Methyl-2-pentanone	0.012	0.997	6.50
	Crotonaldehyde	0.009	0.999	3.84
	Pentanal	0.016	0.999	2.75
	Methyl methacrylate	0.007	0.998	5.50
	1,4-Dioxane	0.007	0.999	5.83
	2-Hexanone	0.009	0.998	4.62
	Hexanal	0.017	0.999	4.20
	Benzaldehyde	0.027	0.997	9.19
	m-Tolualdehyde	0.007	0.996	5.41
Other				
	Carbon disulfide	0.009	0.999	3.43

Table S2. Summary of PMF input data. Concentration units in ppbv.

Species	Category	S/N	Min	25th	Median	75th	Max
Acetylene	Strong	2.32	0.10	0.38	0.70	1.15	4.21
Ethylene	Strong	2.31	0.10	0.32	0.57	1.23	4.26
Propylene	Strong	2.23	0.05	0.15	0.26	0.40	1.19
Isoprene	Strong	1.39	0.00	0.02	0.03	0.04	0.32
Ethane	Strong	8.92	0.31	0.85	1.56	2.40	7.19
Propane	Strong	8.87	0.35	0.93	1.48	2.38	5.82
Isobutane	Strong	8.19	0.04	0.15	0.27	0.62	1.91
n-Butane	Strong	8.92	0.06	0.22	0.44	0.87	2.50
n-Pentane	Strong	8.04	0.04	0.10	0.19	0.50	2.04
2-Methylhexane	Strong	3.50	0.00	0.02	0.03	0.05	0.67
3-Methylhexane	Strong	3.76	0.00	0.01	0.03	0.05	0.18
n-Decane	Strong	2.26	0.00	0.01	0.02	0.03	0.16
n-Undecane	Strong	3.92	0.00	0.01	0.02	0.03	0.07
n-Dodecane	Strong	3.77	0.01	0.02	0.02	0.04	0.10
Freon-11	Strong	8.45	0.14	0.21	0.24	0.27	0.50
Freon-12	Strong	8.93	0.21	0.40	0.43	0.46	0.67
Freon-114	Strong	1.10	0.00	0.02	0.02	0.02	0.40
Chloromethane	Strong	8.10	0.01	0.17	0.24	0.34	0.74
1,1-Dichloroethane	Strong	3.64	0.00	0.01	0.01	0.03	0.10
Carbon tetrachloride	Strong	5.76	0.05	0.08	0.08	0.09	0.17
1,2-Dichloroethane	Strong	7.29	0.02	0.05	0.12	0.33	1.16
1,1,2-Trichloroethane	Strong	4.06	0.01	0.02	0.03	0.03	0.09
1,2,4-Trichlorobenzene	Strong	2.57	0.01	0.02	0.02	0.04	0.40
Carbon disulfide	Strong	3.76	0.01	0.01	0.02	0.05	0.28
Benzene	Strong	8.81	0.08	0.17	0.29	0.56	1.78
Toluene	Strong	8.50	0.05	0.14	0.31	0.57	2.33
Ethylbenzene	Strong	6.75	0.01	0.03	0.08	0.16	0.72
m/p-Xylene	Strong	8.22	0.03	0.09	0.20	0.41	1.79
o-Xylene	Strong	7.16	0.01	0.03	0.08	0.14	0.65
Acetaldehyde	Strong	2.33	0.37	0.82	1.01	1.35	3.32
Acrolein	Strong	2.03	0.02	0.06	0.09	0.13	0.34
Propanal	Strong	2.30	0.06	0.12	0.19	0.27	0.62
Acetone	Strong	2.33	0.68	1.26	1.81	2.52	7.03
MTBE	Strong	5.79	0.01	0.03	0.05	0.13	0.74
2-Butanone	Strong	2.02	0.00	0.04	0.06	0.08	0.16
Butanal	Strong	1.95	0.00	0.07	0.10	0.13	0.28
Crotonaldehyde	Strong	1.54	0.01	0.01	0.02	0.03	0.18
Methacrolein	Weak	0.97	0.01	0.02	0.03	0.04	0.39
1,1-Dichlorethene	Weak	0.64	0.00	0.01	0.01	0.02	0.04

Table S3. The reference exposure level (REL) and cancer potency factor (CPF) of selected VOC species [a].

Species	CAS	Chronic REL ($\mu g/m^3$)	CPF $(mg/kg\text{-}day)^{-1}$
Propylene	115-07-1	3000	
Vinyl chloride	75-01-4		0.27
1,3-Butadiene	106-99-0	2	0.6
Acetaldehyde	75-07-0	140	0.01
Bromomethane	74-83-9	5	
Chloroethane	75-00-3	3000	
Acrolein	107-02-8	0.35	
1,1-Dichlorethene	75-35-4	7	
Carbon disulfide	75-15-0	800	
2-Propanol	67-63-0	7000	
Methylene chloride	75-09-2	400	0.0035
MTBE	1634-04-4	8000	0.0018
n-Hexane	110-54-3	7000	
1,1 -Dichloroethane	75-34-3		0.0057
Vinyl acetate	108-05-4	200	
Trichloromethane	67-66-3	300	0.019
1,1,1 -Trichloroethane	71-55-6	1000	
Carbon tetrachloride	56-23-5	4	0.15
Benzene	71-43-2	3	0.1
1,2-Dichloroethane	107-06-2	400	0.072
Trichloroethene	79-01-6	600	0.007
1,4-Dioxane	123-91-1	300	0.027
Toluene	108-88-3	300	
1,1,2-Trichloroethane	79-00-5		0.057
Tetrachloroethene	127-18-4	3.5	0.021
Ethylene dibromide	106-93-4	8	0.25
Chlorobenzene	108-90-7	1000	
Ethylbenzene	100-41-4	2000	0.0087
m/p-Xylene	108-38-3	700	
o-Xylene	95-47-6	700	
Styrene	100-42-5	900	
1,1,2,2-Tetrachloroethane	79-34-5		0.2
1,4-Dichlorobenzene	106-46-7	800	0.04
Benzyl chloride	100-44-7		0.17
Naphthalene	91-20-3		0.12

a. Data were obtained from (CalEPA, 2015)

Table S4. The target organ systems affected by non-carcinogenic adverse effects of selected VOC species [a].

Species	Target organ systems								
	Alimentary System	Cardiovascular System	Reproductive System	Endocrine System	Eyes	Hematologic System	Kidney System	Nervous System	Respiratory System
Propylene									X
1,3-Butadiene			X						
Acetaldehyde									X
Bromomethane			X					X	X
Chloroethane	X		X						
Acrolein									X
1,1-Dichlorethene	X								
Carbon disulfide	X		X					X	
2-Propanol			X				X		
Methylene chloride		X						X	
MTBE	X				X		X		
n-Hexane								X	
Vinyl acetate									X
Trichloromethane	X		X				X		
1,1,1 -Trichloroethane								X	
Carbon tetrachloride	X		X					X	
Benzene						X			
1,2-Dichloroethane	X								
Trichloroethene					X			X	
1,4-Dioxane	X	X					X		
Toluene			X					X	X
Tetrachloroethene	X						X		
Ethylene dibromide			X						
Chlorobenzene	X		X				X		
Ethylbenzene	X		X	X			X		
m/p-Xylene					X			X	X
o-Xylene					X			X	X
Styrene								X	
1,4-Dichlorobenzene	X						X	X	X

a. Data were obtained from (CalEPA, 2015)

Table S5. Exposure parameters for calculating residential inhalation cancer risk for each age group [a].

Parameter	Unit	Age (years)			
		3rd Trimester	0–2	2–16	16–70
BR/BW(mean)	L/kg-day	225	658	452	185
A	unitless	1	1	1	1
EF	unitless	0.96	0.96	0.96	0.96
ASF	unitless	10	10	3	1
ED	year	0.25	2	14	54
AT	year	70	70	70	70
FAH	unitless	0.85	0.85	0.72	0.73

a. Data were obtained from (CalEPA, 2015)

Table S6. Statistics of VOCs species during P1 and P2.

Species	Compounds	Mean (ppbv)		Min (ppbv)		Median (ppbv)		Max (ppbv)		SD [a] (ppbv)		Ratio of BDL [b] (%)	
		P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Acetylene		0.86	0.90	0.10	0.19	0.62	0.79	4.21	2.44	0.85	0.57	0.00	0.00
Alkenes		1.46	1.36	0.23	0.30	1.04	1.07	5.67	4.40	1.23	0.95		
	Ethylene	0.93	0.84	0.10	0.15	0.56	0.58	4.26	3.16	0.95	0.70	0.00	0.00
	Propylene	0.31	0.30	0.05	0.07	0.26	0.27	1.19	0.78	0.24	0.18	0.00	0.00
	1-Butene	0.09	0.09	0.02	0.02	0.07	0.07	0.27	0.31	0.06	0.06	1.35	1.05
	1,3-Butadiene	0.01	0.02	0.00	0.00	0.01	0.01	0.03	0.06	0.01	0.01	62.16	49.47
	trans-2-Butene	0.02	0.04	0.00	0.00	0.01	0.01	0.15	0.24	0.03	0.05	67.57	57.89
	cis-2-Butene	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.03	0.00	0.01	91.89	90.53
	1-Pentene	0.02	0.01	0.01	0.00	0.01	0.01	0.06	0.04	0.01	0.01	72.97	82.11
	trans-2-Pentene	0.01	0.01	0.00	0.00	0.01	0.01	0.04	0.05	0.01	0.01	89.19	86.32
	cis-2-Pentene	0.01	0.01	0.00	0.00	0.01	0.01	0.06	0.03	0.01	0.01	94.59	89.47
	Isoprene	0.04	0.03	0.01	0.00	0.03	0.03	0.32	0.08	0.04	0.02	8.11	22.11
	1-Hexene	0.01	0.01	0.00	0.00	0.01	0.01	0.06	0.05	0.01	0.01	59.46	52.63
Alkanes		6.84	5.66	1.14	1.63	5.49	4.73	24.29	14.74	5.23	3.30		
	Ethane	1.91	1.80	0.31	0.47	1.53	1.61	7.19	4.67	1.50	1.06	0.00	0.00
	Propane	1.87	1.63	0.35	0.52	1.56	1.45	5.82	3.94	1.27	0.87	0.00	0.00
	Isobutane	0.47	0.37	0.04	0.06	0.33	0.25	1.91	1.13	0.43	0.28	0.00	0.00
	n-Butane	0.67	0.53	0.06	0.14	0.50	0.39	2.50	1.43	0.58	0.38	0.00	0.00
	Isopentane	0.30	0.17	0.03	0.04	0.17	0.13	1.42	0.58	0.33	0.12	0.00	0.00
	n-Pentane	0.41	0.28	0.04	0.06	0.23	0.15	2.04	0.98	0.46	0.25	0.00	0.00
	2,2-Dimethylbutane	0.01	0.01	0.00	0.01	0.01	0.01	0.04	0.04	0.01	0.01	37.84	23.16
	2,3-Dimethylbutane	0.07	0.05	0.00	0.01	0.02	0.03	0.61	0.29	0.13	0.06	17.57	11.58
	2-Methylpentane	0.15	0.10	0.00	0.01	0.11	0.08	0.59	0.47	0.14	0.09	5.41	6.32
	Cyclopentane	0.04	0.02	0.00	0.00	0.02	0.01	0.94	0.14	0.11	0.02	48.65	60.00
	3-Methylpentane	0.09	0.06	0.00	0.01	0.07	0.05	0.38	0.39	0.08	0.06	6.76	0.00
	n-Hexane	0.11	0.07	0.01	0.01	0.06	0.05	0.86	0.33	0.14	0.06	0.00	0.00
	2,4-Dimethylpentane	0.02	0.02	0.01	0.01	0.02	0.01	0.08	0.35	0.02	0.04	36.49	50.53
	Methylcyclopentane	0.07	0.08	0.00	0.00	0.05	0.04	0.44	1.71	0.08	0.18	9.46	4.26
	2-Methylhexane	0.05	0.04	0.00	0.01	0.04	0.03	0.48	0.67	0.06	0.07	14.86	20.00
	Cyclohexane	0.09	0.11	0.01	0.01	0.07	0.11	0.26	0.38	0.06	0.06	0.00	0.00
	2,3-Dimethylpentane	0.02	0.01	0.00	0.00	0.01	0.01	0.10	0.11	0.02	0.02	56.76	78.95
	3-Methylhexane	0.04	0.03	0.01	0.00	0.03	0.02	0.18	0.15	0.04	0.02	10.81	15.79
	2,2,4-Trimethylpentane	0.02	0.01	0.00	0.00	0.02	0.01	0.10	0.08	0.02	0.01	41.89	53.68
	n-Heptane	0.10	0.07	0.01	0.01	0.07	0.05	0.38	0.22	0.09	0.05	0.00	1.05
	Methylcyclohexane	0.05	0.03	0.00	0.00	0.03	0.02	0.21	0.13	0.05	0.02	21.62	32.63
	2,3,4-Trimethylpentane	0.01	0.01	0.00	0.00	0.01	0.01	0.05	0.04	0.01	0.01	70.27	83.16

	2-Methylheptane	0.02	0.01	0.00	0.00	0.01	0.01	0.07	0.05	0.01	0.01	66.22	83.16
	3-Methylheptane	0.02	0.01	0.00	0.00	0.01	0.01	0.05	0.05	0.01	0.01	20.27	49.47
	n-Octane	0.06	0.05	0.01	0.00	0.05	0.03	0.38	0.57	0.06	0.06	5.41	10.53
	n-Nonane	0.03	0.03	0.01	0.01	0.03	0.03	0.10	0.17	0.02	0.02	1.35	5.26
	n-Decane	0.03	0.02	0.00	0.01	0.03	0.02	0.16	0.07	0.02	0.01	12.16	40.00
	n-Undecane	0.03	0.02	0.00	0.01	0.02	0.02	0.07	0.07	0.02	0.01	2.70	11.58
	n-Dodecane	0.03	0.03	0.01	0.01	0.03	0.02	0.09	0.10	0.02	0.02	0.00	5.26
Halohydrocarbons		2.65	2.31	1.08	1.24	2.39	2.25	7.29	4.91	1.47	0.76		
	Freon-11	0.24	0.25	0.14	0.17	0.22	0.25	0.50	0.34	0.08	0.04	0.00	0.00
	Freon-12	0.38	0.46	0.21	0.41	0.38	0.46	0.47	0.67	0.04	0.04	0.00	0.00
	Freon-113	0.25	0.18	0.03	0.03	0.16	0.09	1.13	1.07	0.24	0.20	0.00	0.00
	Freon-114	0.03	0.02	0.01	0.00	0.02	0.02	0.40	0.04	0.05	0.01	60.81	44.21
	Chloromethane	0.28	0.28	0.13	0.01	0.24	0.25	0.74	0.64	0.13	0.13	0.00	1.05
	Vinyl chloride	0.04	0.03	0.00	0.00	0.01	0.02	0.27	0.16	0.07	0.03	60.81	45.26
	Bromomethane	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.04	0.01	0.01	48.65	35.79
	Chloroethane	0.02	0.02	0.00	0.00	0.01	0.01	0.20	0.07	0.04	0.02	71.62	67.37
	Methylene chloride	0.44	0.28	0.05	0.03	0.30	0.25	2.55	1.42	0.47	0.22	0.00	0.00
	Trichloromethane	0.13	0.09	0.02	0.01	0.08	0.06	0.69	0.34	0.14	0.07	0.00	0.00
	Carbon tetrachloride	0.08	0.09	0.06	0.05	0.08	0.09	0.13	0.17	0.02	0.02	0.00	0.00
	1,1-Dichlorethene	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	100.00	98.95
	1,1-Dichloroethane	0.03	0.02	0.00	0.00	0.02	0.01	0.10	0.08	0.03	0.01	21.62	29.47
	trans-1,2-Dichloroethene	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	89.19	94.74
	cis-1,2-Dichloroethylene	0.01	0.01	0.00	0.00	0.01	0.01	0.04	0.03	0.01	0.01	72.97	78.95
	Trichloroethene	0.02	0.01	0.00	0.00	0.01	0.01	0.10	0.04	0.02	0.01	59.46	57.89
	Tetrachloroethene	0.03	0.02	0.00	0.00	0.02	0.02	0.11	0.14	0.03	0.02	27.03	38.95
	1,1,1-Trichloroethane	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.33	0.01	0.04	98.65	95.79
	1,2-Dichloroethane	0.25	0.19	0.02	0.02	0.12	0.12	1.16	0.73	0.29	0.16	0.00	0.00
	1,2-Dichloropropane	0.13	0.07	0.00	0.00	0.06	0.03	0.68	0.24	0.17	0.08	27.03	45.26
	Dibromochloromethane	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.03	0.00	0.01	100.00	94.74
	Bromodichloromethane	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	93.24	95.79
	trans-1,3-Dichloropropene	0.00	0.01	0.00	0.00	0.00	0.00	0.03	0.04	0.00	0.01	98.65	90.53
	cis-1,3-Dichloropropene	0.01	0.01	0.00	0.00	0.01	0.01	0.04	0.03	0.01	0.00	95.95	98.95
	1,1,2-Trichloroethane	0.04	0.02	0.02	0.01	0.03	0.02	0.09	0.05	0.01	0.01	0.00	0.00
	Ethylene dibromide	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	83.78	74.74
	Chlorobenzene	0.02	0.02	0.00	0.00	0.01	0.01	0.19	0.04	0.03	0.01	43.24	40.00
	Bromofomi	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.00	94.59	87.37
	1,1,2,2-Tetrachloroethane	0.01	0.01	0.00	0.00	0.01	0.01	0.17	0.05	0.02	0.01	55.41	43.16
	1,3-Dichlorobenzene	0.03	0.04	0.01	0.01	0.03	0.03	0.13	0.16	0.02	0.02	17.57	2.11
	1,4-Dichlorobenzene	0.03	0.04	0.01	0.01	0.03	0.03	0.15	0.13	0.02	0.02	12.16	0.00
	Benzyl chloride	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.03	0.00	0.00	93.24	83.16
	1,2-Dichlorobenzene	0.01	0.01	0.01	0.00	0.01	0.01	0.03	0.05	0.00	0.01	87.84	77.89
	1,2,4-Trichlorobenzene	0.03	0.03	0.01	0.01	0.02	0.02	0.40	0.08	0.05	0.02	18.92	15.79
	Hexachloro-1,3-butadiene	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.07	0.00	0.01	1.35	1.05

	Carbon disulfide	0.05	0.04	0.01	0.01	0.02	0.02	0.28	0.18	0.07	0.04	17.57	12.63
Aromatics		2.05	1.43	0.34	0.29	1.43	1.20	7.68	4.91	1.77	0.96		
	Benzene	0.44	0.43	0.08	0.09	0.29	0.28	1.78	1.57	0.42	0.35	0.00	0.00
	Toluene	0.57	0.34	0.05	0.05	0.34	0.26	2.33	1.53	0.55	0.28	0.00	0.00
	Ethylbenzene	0.16	0.09	0.02	0.01	0.10	0.06	0.72	0.28	0.17	0.07	0.00	0.00
	m/p-Xylene	0.41	0.23	0.04	0.03	0.24	0.14	1.79	0.75	0.42	0.20	0.00	0.00
	o-Xylene	0.15	0.09	0.01	0.01	0.09	0.06	0.65	0.25	0.15	0.07	0.00	0.00
	Styrene	0.04	0.03	0.01	0.01	0.03	0.02	0.11	0.06	0.02	0.01	0.00	6.32
	Isopropylbenzene	0.01	0.02	0.00	0.00	0.01	0.02	0.05	0.04	0.01	0.01	59.46	30.53
	n-Propylbenzene	0.02	0.01	0.00	0.00	0.02	0.01	0.05	0.05	0.01	0.01	40.54	42.11
	p-Ethyltoluene	0.03	0.02	0.00	0.00	0.03	0.02	0.08	0.13	0.02	0.02	18.92	33.68
	m-Ethyltoluene	0.02	0.02	0.00	0.00	0.02	0.02	0.06	0.07	0.01	0.01	25.68	30.53
	1,3,5-Trimethylbenzene	0.02	0.02	0.01	0.00	0.01	0.01	0.07	0.05	0.02	0.01	13.51	23.16
	o-Ethyltoluene	0.02	0.02	0.00	0.00	0.01	0.02	0.08	0.06	0.01	0.01	36.49	25.26
	1,2,4-Trimethylbenzene	0.04	0.03	0.01	0.01	0.03	0.02	0.14	0.10	0.03	0.02	0.00	9.47
	1,2,3-Trimethylbenzene	0.01	0.01	0.00	0.00	0.01	0.01	0.04	0.06	0.01	0.01	24.32	43.16
	m-Diethylbenzene	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.04	0.01	0.01	82.43	78.95
	p-Diethylbenzene	0.01	0.01	0.00	0.00	0.01	0.01	0.05	0.05	0.01	0.01	72.97	80.00
	Naphthalene	0.08	0.06	0.01	0.01	0.07	0.05	0.21	0.15	0.03	0.03	1.35	1.05
OVOCs		5.52	4.56	2.85	1.79	5.08	3.99	12.59	10.36	2.20	1.94		
	Acetaldehyde	1.03	1.16	0.37	0.45	0.98	1.06	2.36	3.32	0.41	0.46	0.00	0.00
	Acrolein	0.11	0.09	0.03	0.02	0.09	0.08	0.34	0.25	0.07	0.05	0.00	1.05
	Propanal	0.25	0.19	0.10	0.06	0.21	0.15	0.62	0.41	0.13	0.10	0.00	0.00
	Acetone	2.16	1.89	1.19	0.68	2.01	1.46	4.22	7.03	0.75	1.08	0.00	0.00
	2-Propanol	0.33	0.20	0.08	0.04	0.24	0.15	0.92	0.85	0.21	0.15	0.00	0.00
	MTBE	0.10	0.08	0.01	0.01	0.07	0.05	0.46	0.74	0.09	0.11	6.76	6.32
	Methacrolein	0.05	0.03	0.01	0.01	0.03	0.03	0.39	0.06	0.06	0.01	37.84	45.26
	Vinyl acetate	0.01	0.01	0.00	0.00	0.01	0.01	0.04	0.04	0.01	0.01	74.32	84.21
	2-Butanone	0.07	0.06	0.00	0.01	0.07	0.05	0.16	0.16	0.03	0.03	4.05	3.16
	Butanal	0.13	0.09	0.00	0.01	0.12	0.09	0.27	0.28	0.05	0.04	2.70	5.26
	Ethyl acetate	0.47	0.21	0.02	0.01	0.26	0.15	2.50	0.79	0.56	0.19	0.00	6.32
	Tetrahydrofuran	0.04	0.02	0.01	0.01	0.03	0.02	0.76	0.09	0.09	0.02	44.59	66.32
	4-Methyl-2-pentanone	0.05	0.04	0.01	0.01	0.04	0.03	0.19	0.11	0.04	0.02	8.11	9.47
	Crotonaldehyde	0.03	0.02	0.01	0.01	0.03	0.02	0.18	0.10	0.03	0.01	8.11	14.74
	Pentanal	0.11	0.10	0.05	0.01	0.10	0.08	0.32	0.32	0.05	0.06	0.00	2.11
	Methyl methacrylate	0.01	0.01	0.00	0.00	0.01	0.01	0.08	0.06	0.01	0.01	17.57	34.74
	1,4-Dioxane	0.01	0.01	0.00	0.00	0.01	0.01	0.09	0.07	0.01	0.01	51.35	48.42
	2-Hexanone	0.02	0.02	0.00	0.00	0.02	0.01	0.13	0.11	0.02	0.02	25.68	44.21
	Hexanal	0.41	0.26	0.07	0.07	0.36	0.24	1.18	0.74	0.25	0.16	0.00	0.00
	Benzaldehyde	0.06	0.04	0.02	0.01	0.05	0.04	0.22	0.13	0.04	0.02	6.76	26.32
	m-Tolualdehyde	0.06	0.04	0.01	0.01	0.05	0.04	0.36	0.23	0.06	0.03	1.35	0.00

a. SD: standard deviation. b. BDL: below detection limit.

Table S7. Substance-specific chronic inhalation hazard quotients (HQs) and the hazard index (HI) by target organ system during P1 and P2.

Speiceis	Alimentary System		Cardiovascular System		Reproductive System		Endocrine System		Eyes		Hematologic System		Kidney System		Nervous System		Respiratory System	
	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2	P1	P2
Propylene																	1.91E-04	1.82E-04
1,3-Butadiene					1.51E-02	1.97E-02												
Acetaldehyde																	1.27E-02	1.58E-02
Bromomethane					1.10E-02	1.12E-02									1.10E-02	1.12E-02	1.10E-02	1.12E-02
Chloroethane	2.15E-06	1.64E-06			2.15E-06	1.64E-06												
Acrolein																	7.93E-01	6.15E-01
1,1-Dichlorethene	2.15E-03	3.02E-03																
Carbon disulfide	2.41E-04	1.64E-04			2.41E-04	1.64E-04									2.41E-04	1.64E-04		
2-Propanol					1.21E-04	7.32E-05							1.21E-04	7.32E-05				
Methylene chloride			4.26E-03	2.51E-03											4.26E-03	2.51E-03		
MTBE	4.64E-05	4.06E-05							4.64E-05	4.06E-05			4.64E-05	4.06E-05				
n-Hexane															5.81E-05	3.46E-05		
Vinyl acetate																	1.40E-04	1.21E-04
Trichloromethane	2.55E-03	1.46E-03			2.55E-03	1.46E-03							2.55E-03	1.46E-03				
1,1,1 -Trichloroethane															2.18E-05	4.08E-05		
Carbon tetrachloride	1.32E-01	1.46E-01			1.32E-01	1.46E-01									1.32E-01	1.46E-01		
Benzene											5.45E-01	5.09E-01						
1,2-Dichloroethane	2.63E-03	2.00E-03																
Trichloroethene									1.35E-04	1.06E-04					1.35E-04	1.06E-04		
1,4-Dioxane	1.15E-04	1.09E-04	1.15E-04	1.09E-04									1.15E-04	1.09E-04				
Toluene					6.97E-03	4.46E-03									6.97E-03	4.46E-03	6.97E-03	4.46E-03
Tetrachloroethene	5.97E-02	4.24E-02											5.97E-02	4.24E-02				
Ethylene dibromide					4.15E-03	5.12E-03												
Chlorobenzene	1.09E-04	7.66E-05			1.09E-04	7.66E-05							1.09E-04	7.66E-05				
Ethylbenzene	3.32E-04	2.35E-04			3.32E-04	2.35E-04	3.32E-04	2.35E-04					3.32E-04	2.35E-04				
m/p-Xylene									2.49E-03	1.63E-03					2.49E-03	1.63E-03	2.49E-03	1.63E-03
o-Xylene									2.49E-03	1.63E-03					2.49E-03	1.63E-03	2.49E-03	1.63E-03
Styrene															1.81E-04	1.38E-04		
1,4-Dichlorobenzene	2.69E-04	2.95E-04											2.69E-04	2.95E-04	2.69E-04	2.95E-04	2.69E-04	2.95E-04
HI	2.00E-01	1.97E-01	4.38E-03	2.62E-03	1.73E-01	1.89E-01	3.32E-04	2.35E-04	5.16E-03	3.41E-03	5.27E-01	5.08E-01	6.32E-02	4.47E-02	1.60E-01	1.69E-01	8.34E-01	6.51E-01

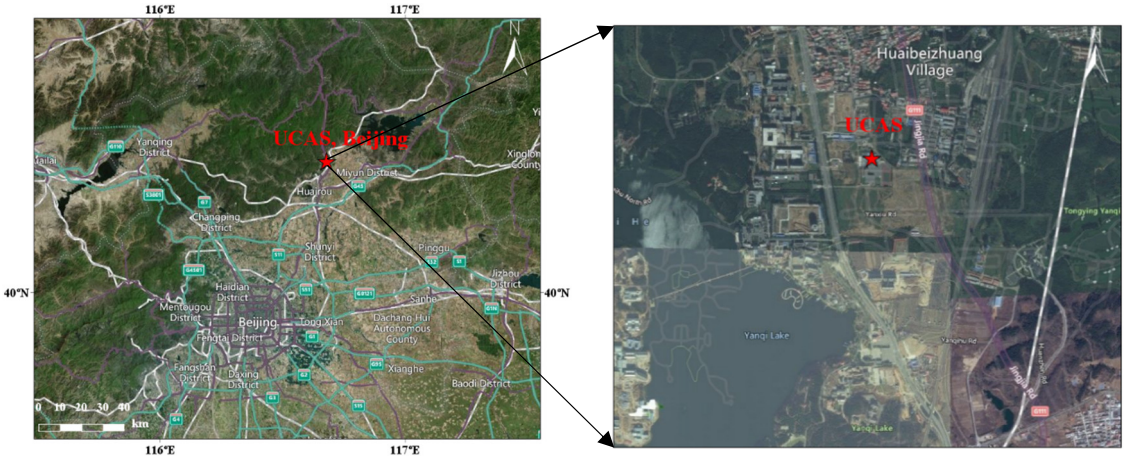


Figure S1. Location of the sampling site in UCAS, Beijing.

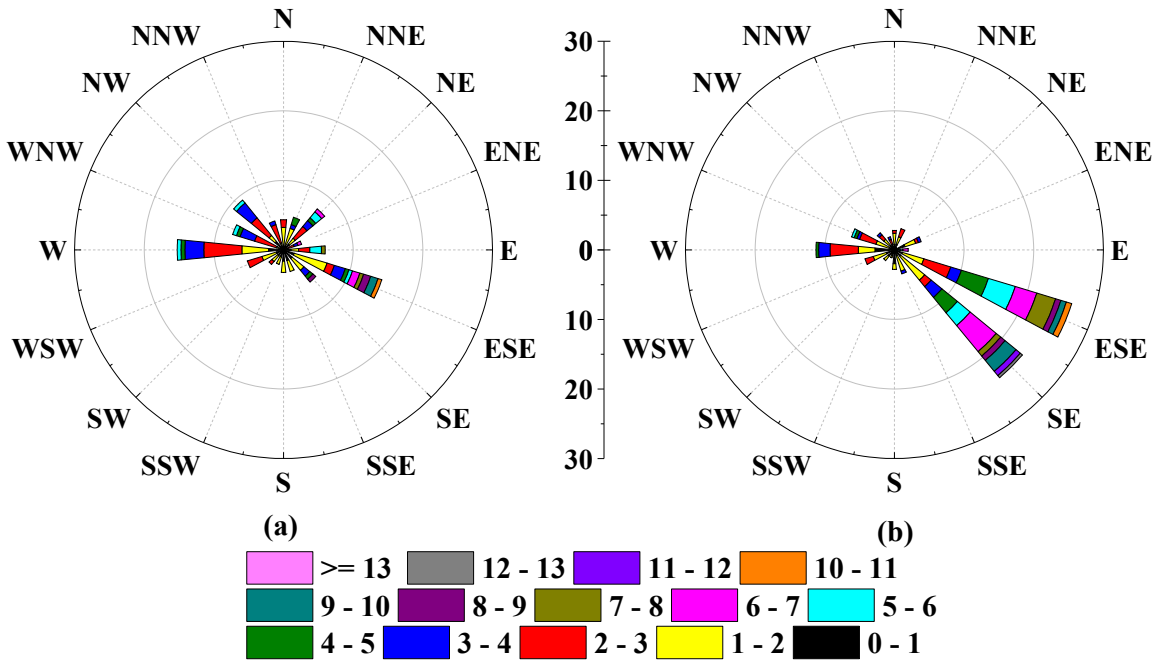


Figure S2. Wind rose diagrams during (a) P1 and (b) P2.

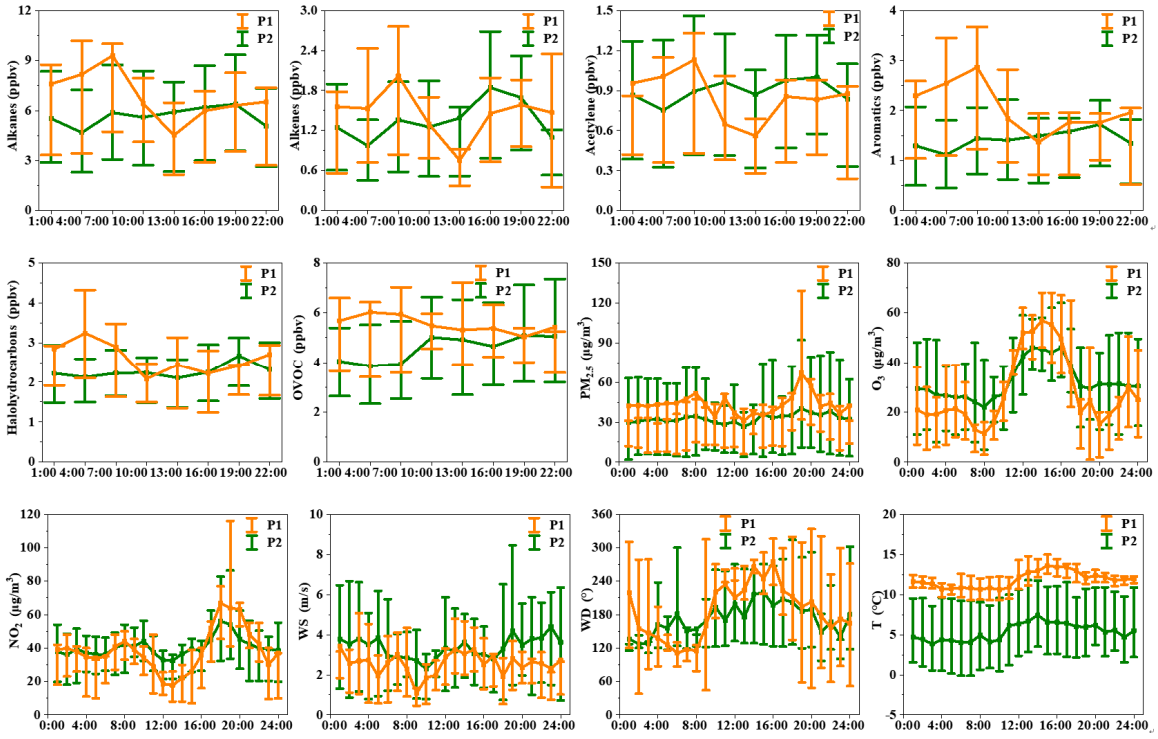


Figure S3. Diurnal variations of VOC groups, $PM_{2.5}$, NO_2, O_3 and meteorological parameters (T, WD and WS) during P1 and P2.

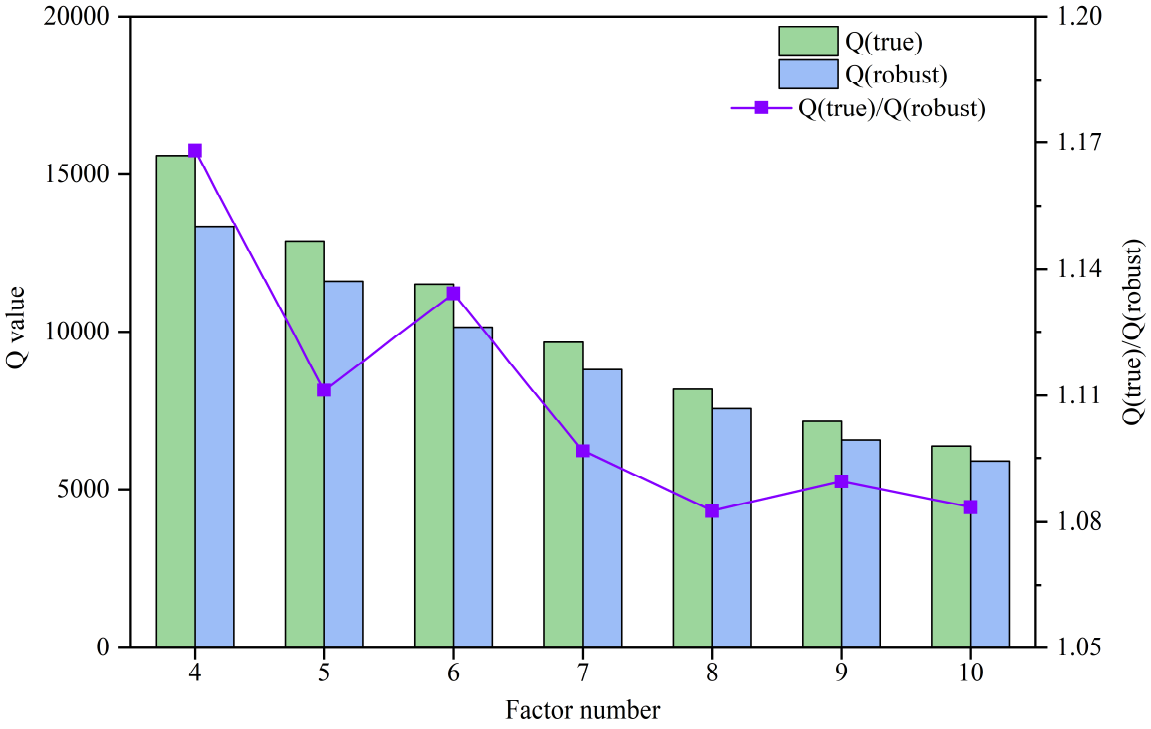
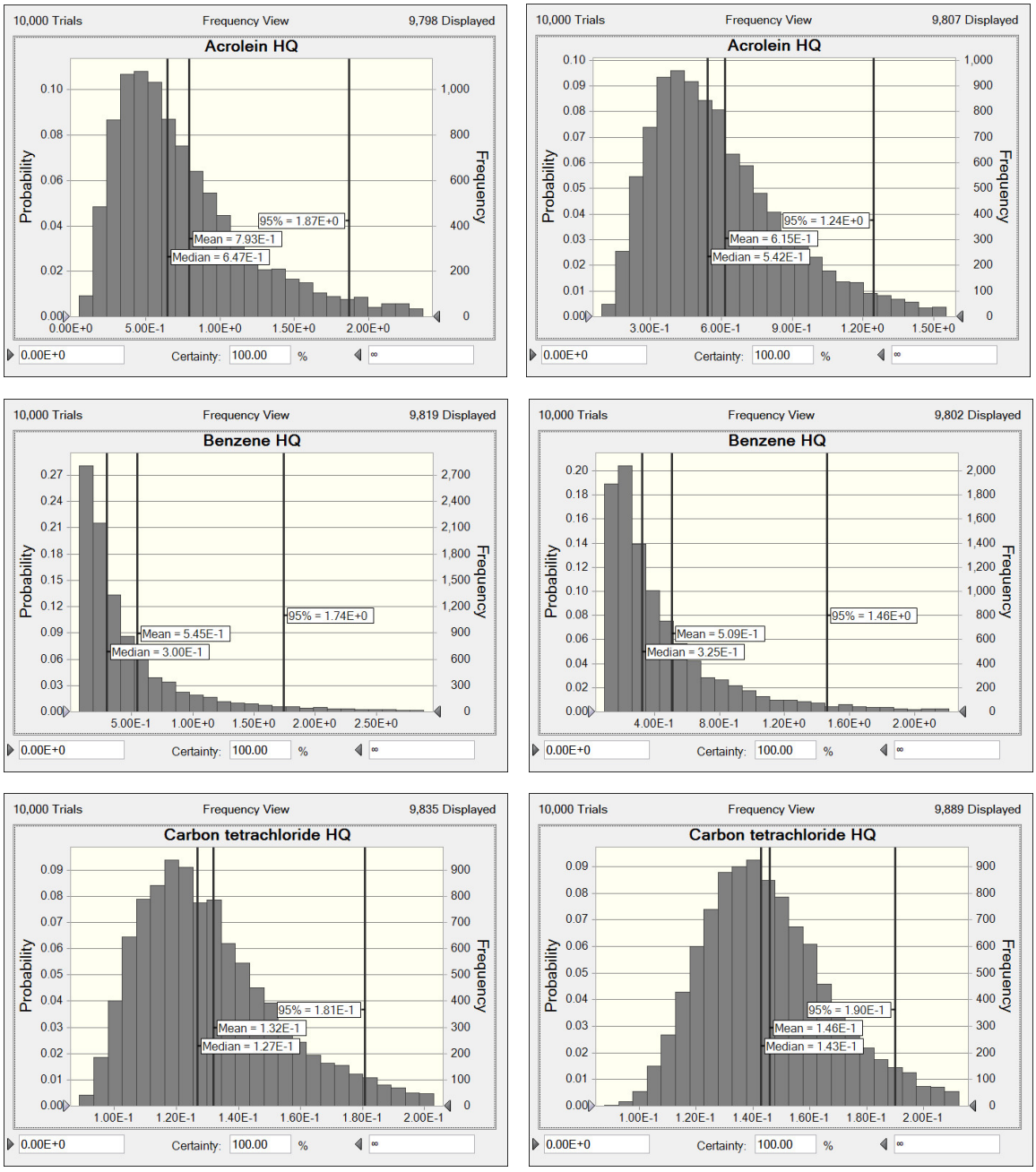


Figure S4. Variation of Q Value with Factor in PMF Model.



(a) (b)

Figure S5. Probability distribution of HQ of selected VOC species during (a) P1 and (b) P2.