Supplementary materials for

Source analyses of ambient VOCs considering reactive losses: methods of reducing loss effects, impacts of losses, and sources

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Text S1. Estimation methods of the decay factors.

Method 1:

In 1981, Friedlander (1981) proposed treating an urban airshed as a continuous stirred tank reactor (CSTR) and relating the decay factor for a given species to its first-order reaction rate constant, k_i.

$$\alpha_i = (1 + k_i\theta)^{-1} \tag{1}$$

$$\theta = \frac{V}{q} \tag{2}$$

where α_i represents the decay factor of species i, θ represents the average residence time, V is the reactor volume, and q is the flow rate. This method considered only the first-order reaction of a given species, and there was high uncertainty in the average residence time.

Method 2:

In 1994, Lin and Milford (1994) first estimated the decay factor utilizing the reaction rate constants of VOC species and "aging coefficients". In 2007, Na and Pyo Kim (2007) also conducted a similar estimation utilizing this method. The specific estimation method of the decay factor (α_{ij}) was as follows:

$$\alpha_{ij} = \exp\,(-k_i\xi) \tag{3}$$

where k_i is the rate constant for the reaction of species i with the OH radical, and ξ is an empirically estimated "aging coefficient". To estimate ξ for a given sample, source contributions estimated with α_{ij} = 1.0 were used to calculate preliminary predicted concentrations, c^*_i. With the normalized residual (E_i) for species i defined as:

$$E_i = \frac{c_i^* - c_i}{c_i} \tag{4}$$

the linear expression:

$$\ln(E_i + 1) = -A + \xi k_i \tag{5}$$

where the ξ value can be estimated for each sample utilizing the linear regression. However, this method had two important limitations: First, for a given sample, the aging coefficient was assumed to be the same for all species and sources; second, rates of reaction of alkenes with NO_3 radicals and O_3 were neglected.

Table S1. Summary of sampling information and species concentration data from reviewed publications using PMF for VOC source analyses.

Literature	City/Region	Study period	Unit	TVOCs	PAMS	Alkanes	Alkenes	Aromatic hydrocarbons	Alkyne	OVOCs	Halohydrocarbons	Others
Ling et al. (2011)	PRD region	2007/10/23-2007/12/1	μgm^{-3}	81.01	81.01	27.84	5.08	43.53	4.56	-	-	-
Chen et al. (2019)	Taixi, Taiwan	2014	ppbv	11.19	11.19	6.28	2.11.	1.94	0.86	-	-	-
Chen et al. (2019)	Taixi, Taiwan	2015	ppbv	11.58	11.58	6.67	1.87	2.12	0.92	-	-	-
Chen et al. (2019)	Taixi, Taiwan	2016	ppbv	10.44	10.44	6.25	1.54	1.82	0.83	-	-	-
Zheng et al. (2018)	Junggar Basin	2014/9-2015/8	ppbv	145.83	145.83	129	9.52	4.28	3.03	-	-	-
Ling and Guo (2014)	Hong Kong	2010/9/6-2010/11/29	-	-	-	-	-	-	-	-	-	-
Tan et al. (2020)	Chengdu	2017/7/31-2017/8/6	ppbv	14.4	14.34	10	0.89	1.01	2.44	-	-	-
Tan et al. (2020)	Chengdu	2017/8/7-2017/8/31	ppbv	11.8	11.77	6.28	2.57	0.79	2.13	-	-	-
Tan et al. (2020)	Chengdu	2017/7/31-2017/8/6	ppbv	52.8	31.38	16.5	3.77	7.85	3.26	13.3	7.7	-
Tan et al. (2020)	Chengdu	2017/8/7-2017/8/31	ppbv	34.9	21.9	12.3	2.79	4.41	2.4	7.68	4.9	-
Tan et al. (2020)	Chengdu	2017/7/31-2017/8/6	ppbv	60.6	32.94	18.4	4.46	7.27	2.81	20.5	6.7	-
Tan et al. (2020)	Chengdu	2017/8/7-2017/8/31	ppbv	47.0	32.73	23.7	3.12	3.32	2.59	9.81	4.14	-
Brown et al. (2007)	Los Angeles	2001/7-9, 2002/7-9, 2003/7-9	ppbC	79	-	-	-	-	-	-	-	-
Brown et al. (2007)	Los Angeles	2001/7-9, 2002/7-9, 2003/7-9	ppbC	237	-	-	-	-	-	-	-	-
Zhang et al. (2013)	Guangzhou	2009/11/8-2009/12/7	ppbv	-	-	-	-	9.26	-	-	-	-
Zhang et al. (2013)	Guangzhou	2009/11/8-2009/12/7	ppbv	-	-	-	-	6.4	-	-	-	-
Zhang et al. (2013)	Zengcheng	2009/11/8-2009/12/7	ppbv	-	-	-	-	2.5	-	-	-	-
Zhang et al. (2013)	Wanqingsha	2009/11/8-2009/12/7	ppbv	-	-	-	-	10.4	-	-	-	-

Guo et al. (2011)	PRD center	2007/10-2007/12	ppbv	42	-	-	-	-	-	-	-	-
Guo et al. (2011)	Hong Kong	2007/10-2007/13	ppbv	34	-	-	-	-	-	-	-	-
Shao et al. (2016)	Nanjing	2013/5/15-2013/8/31	ppbv	34.4	34.4	14.98	7.35	9.06	3.01	-	-	-
Liu et al. (2023a)	Tianjin	2020/4/15-2020/8/31	ppbv	19.35	19.35	11.3	5.32	1.6	1.13	-	-	-
Hui et al. (2019)	Wuhan	2016/10/15-2016/10/20	ppbv	58.33	13.23	18.84.	5.9	4.89	2.44	20.67	5.11	0.48
Hui et al. (2019)	Wuhan	2016/11/2-2016/11/6	ppbv	45.84	32.75	19.79	5.12	4.81	3.03	7.26	5.38	0.45
Hui et al. (2019)	Wuhan	2016/11/11-2016/11/16	ppbv	57.73	43.87	26.56	7.58	5.65	4.08	7.08	6.24	0.54
Liu et al. (2020)	Beijing	2016/4; 2016/7; 2016/10	ppbv	44	27.96	16.2	5.24	3.39	3.13	11	4.76	0.3
Xiong et al. (2021)	Chengdu	2018/6	ppbv	26.8	22.3	11.9	3.76	3.18	3.46	-	4.47	-
Xiong et al. (2021)	Chengdu	2019/1	ppbv	53.3	49.67	29.2	6.55	5.46	8.46	-	3.62	-
Zhu et al. (2017)	Mt. Tai	2014/6/4-2014/7/4	pptv	8040	7947	4464	906	1179	1398	-	-	94
Yang et al. (2019)	Xianghe	2017/11/6-2018/1/29	ppbv	61.04	48.44	23.66	12.27	8.27	4.24	5.18	8.47	0.32
Li et al. (2019)	Zhengzhou	2017/5	ppbv	37.6	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/6	ppbv	34	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/7	ppbv	16	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/8	ppbv	21.5	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/9	ppbv	26.2	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/5	ppbv	29.3	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/6	ppbv	30.3	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/7	ppbv	20.7	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/8	ppbv	24.4	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/9	ppbv	34.2	-	-	-	-	-	-	-	-

Li et al. (2019)	Zhengzhou	2017/5	ppbv	31.7	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/6	ppbv	39.3	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/7	ppbv	19.6	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/8	ppbv	20.5	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/9	ppbv	30.4	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/5	ppbv	30.1	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/6	ppbv	28.3	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/7	ppbv	15.9	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/8	ppbv	26.1	-	-	-	-	-	-	-	-
Li et al. (2019)	Zhengzhou	2017/9	ppbv	32.6	-	-	-	-	-	-	-	-
Liu et al. (2016)	Tianjin	2015/3	ppbv	19.6	19.7	14.2	4.2	1.3	-	-	-	-
Liu et al. (2016)	Tianjin	2015/4	ppbv	22.6	22.5	15.9	4.3	2.3	-	-	-	-
Liu et al. (2016)	Tianjin	2015/5	ppbv	14.4	14.4	11.1	2.4	0.9	-	-	-	-
Liu et al. (2016)	Tianjin	2015/6	ppbv	10.4	10.5	7.4	2.3	0.8	-	-	-	-
Liu et al. (2016)	Tianjin	2015/7	ppbv	34.5	34.5	20.1	4.4	10	-	-	-	-
Liu et al. (2016)	Tianjin	2015/8	ppbv	48.9	49	21.3	5.9	21.8	-	-	-	-
Liu et al. (2016)	Tianjin	2015/9	ppbv	44.8	45	30	5.3	9.7	-	-	-	-
Liu et al. (2016)	Tianjin	2015/1	ppbv	31.8	31.9	19.7	5.3	6.9	-	-	-	-
Liu et al. (2016)	Tianjin	2014/11	ppbv	30	30	20.5	5.7	3.8	-	-	-	-
Liu et al. (2016)	Tianjin	2014/12	ppbv	26.9	27	18.2	6.4	2.4	-	-	-	-
Liu et al. (2016)	Tianjin	2015/1	ppbv	39.4	39.4	26.3	10.2	2.9	-	-	-	-
Liu et al. (2016)	Tianjin	2015/2	ppbv	20.9	20.9	14.3	5.6	1	-	-	-	-

Guan et al. (2020)	Shijiazhuang	2018/7/6-2018/7/15	ppbv	-	-	-	-	-	-	-	-	-
Gao et al. (2020)	Yuncheng	2018/1/20-2018/1/24	μgm^{-3}	87.7	84.92	53.5	8.8	20.02	2.6	-	-	-
Hui et al. (2020)	Wuhan	2017/4/26-2017/6/6	ppbv	28.92	21.74	14.79	2.9	2.25	1.8	3.8	3.16	0.22
Huang and Hsieh (2020)	Taipei	2017	μgm^{-3}	76.0	76.0	40.9	7.3	24.7	3.1	-	-	-
Huang and Hsieh (2020)	Taipei	2017	μgm^{-3}	65.0	65.0	34.8	4.8	24.5	1.0	-	-	-
Huang and Hsieh (2020)	Taichung	2017	μgm^{-3}	64.9	64.9	30.2	5.5	27.5	1.8	-	-	-
Huang and Hsieh (2020)	Tainan	2017	μgm^{-3}	65.2	65.2	32.2	5.9	26.3	0.8	-	-	-
Huang and Hsieh (2020)	Kaohsiung	2017	μgm^{-3}	53.4	53.4	26.8	5.8	19.9	1.0	-	-	-
Huang and Hsieh (2020)	Kaohsiung	2017	μgm^{-3}	58.2	58.2	31.3	6.7	18.9	1.5	-	-	-
Huang and Hsieh (2020)	Yunlin	2017	μgm^{-3}	21.7	21.7	11.8	3.0	6.0	0.7	-	-	-
Huang and Hsieh (2020)	Chiayi	2017	μgm^{-3}	40.1	40.1	22.1	4.4	13.0	0.5	-	-	-
Huang and Hsieh (2020)	Pingtung	2017	μgm^{-3}	34.9	34.9	18.1	3.9	11.0	1.9	-	-	-
Zhao et al. (2020)	Nanjing	2016	ppbv	25.7	25.7	13.6	3.2	4.4	4.5	-	-	-
Hui et al. (2021)	Weinan	2019/7/1-2019/9/19	ppbv	30.42	22.91	14.94	3.3	2.42	2.25	4.36	3.02	0.13
Zhou et al. (2022)	Beijing	2020/11/5-2020/11/14	ppbv	19.43	11.21	6.84	1.46	2.05	0.86	5.52	2.65	-
Zhou et al. (2022)	Beijing	2020/11/15-2020/11/26	ppbv	16.25	9.35	5.66	1.36	1.43	0.9	4.56	2.31	-
Gu et al. (2022)	Tianjin	2019/11/1-2020/3/31	ppbv	27.6	27.6	18.6	4.3	2.5	2.2	-	-	-
Yang et al. (2022)	Tianjin	2020/12/1-2021/3/15	ppbv	24.2	24.13	16.5	3.99	2.18	1.46	-	-	-
Yu et al. (2023)	Hefei	2020/8/18-2020/9/2	ppbv	42.26	13.22	8.99	2.62	1.61	-	22.13	5.63	1.3
Cao et al. (2023)	Hainan	2019/1-2019/12	ppbv	11.4	11.39	8.15	1.32	1.03	0.89	-	-	-
Wang et al. (2023a)	Taiyuan	2021/7/16-2022/1/4	ppbv	21.97	21.97	13.42	5	1.57	1.98	-	-	-
Wu et al. (2023b)	Qingdao	2020/3/11-2020/5/31	μgm^{-3}	57.4	57.45	37.1	5.96	13.8	0.59	-	-	-

Liu et al. (2023b)	Beijing	2019/8/1-2019/8/28	ppbv	94.26	86.6	53.51	2.53	29.88	0.68	7.34	-	-
Liu et al. (2023b)	Beijing	2019/8/1-2019/8/28	ppbv	20.69	12.27	8.31	1.21	2.36	0.39	8.12	-	-
Tan et al. (2021)	Hong Kong	2018/8/27-2018/10/10	ppbv	9.38	1.27	-	0.47	0.8	-	7.91	-	0.2

The data from the same city at different or same times were derived mainly from multiple sampling sites.

Table S2. Summary of methods for reducing reactive loss impacts in the VOC source analyses.

Literature	Models	Reduce reactive loss impact methods
Ling et al. (2011)	PMF	Input low reactivity species
Chen et al. (2019)	PMF	Input low reactivity species
Zheng et al. (2018)	PMF	Input low reactivity species
Ling and Guo (2014)	PMF	Input low reactivity species
Tan et al. (2020)	PMF	Input low reactivity species
Brown et al. (2007)	PMF	Input low reactivity species
Zhang et al. (2013)	PMF	Input low reactivity species
Guo et al. (2011)	PMF	Input low reactivity species
Shao et al. (2016)	PMF	Input low reactivity species
Liu et al. (2023a)	PMF	Input low reactivity species and calculate initial concentrations
Hui et al. (2019)	PMF	Input low reactivity species
Liu et al. (2020)	PMF	Input low reactivity species
Xiong et al. (2021)	PMF	Input low reactivity species
Zhu et al. (2017)	PMF	Input low reactivity species

Yang et al. (2019)	PMF	Input low reactivity species
Li et al. (2019)	PMF	Input low reactivity species
Liu et al. (2016)	PMF	Input low reactivity species
Guan et al. (2020)	PMF	Input low reactivity species
Gao et al. (2020)	PMF	Input low reactivity species
Hui et al. (2020)	PMF	Input low reactivity species
Huang and Hsieh (2020)	PMF	Input low reactivity species
Zhao et al. (2020)	PMF	Input low reactivity species
Hui et al. (2021)	PMF	Input low reactivity species
Zhou et al. (2022)	PMF	Input low reactivity species
Gu et al. (2022)	PMF	Input low reactivity species
Yang et al. (2022)	PMF	Input low reactivity species and calculate initial concentrations
Yu et al. (2023)	PMF	Input low reactivity species
Cao et al. (2023)	PMF	Input low reactivity species
Wang et al. (2023a)	PMF	Input low reactivity species
Buzcu and Fraser (2006)	PMF	Input nighttime data
BuzcuGuven and Fraser (2008)	PMF	Input nighttime data
Lin and Milford (1994)	CMB	Decay factor method
Friedlander (1981)	CMB	Decay factor method
Na and Pyo Kim (2007)	CMB	Decay factor method
He et al. (2019)	PMF	Calculate initial concentration
Wang et al. (2023b)	PMF	Calculate initial concentration
Sun et al. (2016)	PMF	Calculate initial concentration

Zou et al. (2023)	PMF	Calculate initial concentration
Wu et al. (2023a)	PMF	Calculate initial concentration
Wu et al. (2023b)	PMF	Input low reactivity species and calculate initial concentrations
Zhu et al. (2021)	Photochemical age-based method	/
de Gouw et al. (2005)	Photochemical age-based method	/
Huang et al. (2020)	Photochemical age-based method	/
Yuan et al. (2012)	Photochemical age-based method	/
Wang et al. (2016)	Photochemical age-based method	/
Han et al. (2019)	Photochemical age-based method	/
Wu et al. (2020)	Photochemical age-based method	/

Table S3. The type and quantity of input species in PMF for VOC source apportionment in the publications.

Literature	Input Species	PAMS	Alkanes	Alkenes	Aromatic hydrocarbons	Alkyne	OVOCs	Halohydrocarbons	Others
Ling et al. (2011)	22	22	10	3	8	1	0	0	0
Chen et al. (2019)	27	27	17	3	6	1	0	0	0
Zheng et al. (2018)	20	20	14	1	4	1	0	0	0
Ling and Guo (2014)	25	25	12	3	9	1	0	0	0
Tan et al. (2020)	82	54	29	8	16	1	14	14	0
Brown et al. (2007)	31	31	19	2	9	1	0	0	0
Zhang et al. (2013)	33	33	13	6	13	1	0	0	0
Guo et al. (2011)	16	16	9	1	5	1	0	0	0
Shao et al. (2016)	33	33	15	6	11	1	0	0	0
Liu et al. (2023a)	32	32	17	5	9	1	0	0	0
Hui et al. (2019)	43	35	18	6	10	1	0	7	1
Liu et al. (2020)	39	31	15	6	9	1	5	2	1
Xiong et al. (2021)	30	26	14	3	8	1	3	1	0
Zhu et al. (2021)	28	28	14	4	9	1	0	0	0
Yang et al. (2019)	48	25	9	5	10	1	7	15	1
Li et al. (2019)	30	30	15	8	6	1	0	0	0
Liu et al. (2016)	31	31	17	5	9	0	0	0	0
Guan et al. (2020)	35	15	6	4	4	1	12	7	1
Gao et al. (2020)	37	37	19	7	10	1	0	0	0
Hui et al. (2020)	41	32	16	4	11	1	2	7	1
Huang and Hsieh (2020)	15	15	7	2	5	1	0	0	0
Zhao et al. (2020)	25	25	11	6	7	1	0	0	0
Hui et al. (2021)	30	24	13	5	5	1	1	4	1

Zhou et al. (2022)	38	19	10	3	5	1	9	9	1
Gu et al. (2022)	30	30	16	5	8	1	0	0	0
Yang et al. (2022)	30	30	17	5	7	1	0	0	0
Yu et al. (2023)	27	17	8	4	5	0	4	6	0
Cao et al. (2023)	34	34	16	8	9	1	0	0	0
Wang et al. (2023a)	35	34	16	9	8	1	1	0	0
Wu et al. (2023b)	27	27	14	6	6	1	0	0	0
Li et al. (2023)	34	30	18	2	9	1	4	0	0
Li et al. (2023)	24	20	14	2	4	0	4	0	0
Liu et al. (2023b)	29	26	14	4	7	1	3	0	0
Tan et al. (2021)	16	4	0	1	3	0	7	0	5

Table S4. Summary of k_{OH} values of PAMS species used in the publications.

Species	k_{OH} (Carter, 2010) (cm^3 molecule^{-1} s^{-1})	k_{OH} (Atkinson and Arey, 2003)	Species	k_{OH} (Carter, 2010) (cm^3 molecule^{-1} s^{-1})	k_{OH} (Atkinson and Arey, 2003)
Temperature	300°K	298°K	Temperature	300°K	298°K
Alkanes			**Alkenes**		
Ethane	2.54E-13	2.48E-13	Ethylene	8.15E-12	8.52E-12
Propane	1.11E-12	1.09E-12	Propene	2.6E-11	2.63E-11
i-Butane	2.14E-12	-	trans-2-Butene	6.32E-11	6.4E-11
n-Butane	2.38E-12	2.36E-12	1-Butene	3.11E-11	3.14E-11
2,2-Dimethylbutane	2.27E-12	2.23E-12	cis-2-Butene	5.58E-11	5.64E-11
2,3-Dimethylbutane	5.79E-12	5.78E-12	1-Pentene	3.14E-11	3.14E-11
n-Pentane	3.84E-12	3.8E-12	trans-2-Pentene	6.7E-11	6.7E-11
i-Pentane	3.6E-12	-	cis-2-Pentene	6.5E-11	6.5E-11
Cyclopentane	5.02E-12	4.97E-12	Isoprene	9.96E-11	1E-10
Methylcyclopentane	5.68E-12	-	1-Hexene	3.7E-11	3.7E-11
2-Methylpentane	5.2E-12	5.2E-12	**Aromatic hydrocarbons**		
3-Methylpentane	5.2E-12	5.2E-12	Benzene	1.22E-12	1.22E-12
2,4-Dimethylpentane	4.77E-12	4.77E-12	Toluene	5.58E-12	5.63E-12
2,3-Dimethylpentane	7.15E-12	-	Ethylbenzene	7E-12	7E-12
2,3,4-Trimethylpentane	6.6E-12	6.6E-12	o-Xylene	1.36E-11	1.36E-11
2,2,4-Trimethylpentane	3.38E-12	3.34E-12	i-Propylbenzene	6.3E-12	6.3E-12
n-Hexane	5.25E-12	5.2E-12	n-Propylbenzene	5.8E-12	5.8E-12
3-Methylhexane	7.17E-12	-	m-Ethyltoluene	1.86E-11	1.86E-11
Methylcyclohexane	9.64E-12	9.64E-12	p-Ethyltoluene	1.18E-11	1.18E-11
Cyclohexane	7.02E-12	6.97E-12	o-Ethyltoluene	1.19E-11	1.19E-11

2-Methylhexane	6.89E-12	-	1,3,5-Trimethylbenzene	5.67E-11	5.67E-11
n-Heptane	6.81E-12	6.76E-12	1,2,4-Trimethylbenzene	3.25E-11	3.25E-11
2-Methylheptane	8.31E-12	-	1,2,3-Trimethylbenzene	3.27E-11	3.27E-11
3-Methylheptane	8.59E-12	-	m-Diethylbenzene	0	-
n-Octane	8.16E-12	8.11E-12	p-Diethylbenzene	0	-
n-Nonane	9.75E-12	9.7E-12	Styrene	5.8E-11	5.8E-11
n-Decane	1.1E-11	1.1E-11	m-xylene	2.31E-11	2.31E-11
Alkyne			p-xylene	1.43E-11	1.43E-11
Acetylene	7.56E-13	-			

Table S5. Summary of estimation methods for calculating photochemical age (reaction time, Δt) in the publications.

Number	Study area	Δt calculation methods	Publication Year	Literature
1	Sydney	Species ratio method	1983	Nelson and Quigley (1983)
2	Nashvill	Sequential reaction model	2001	Stroud et al. (2001)
3	Boston	Species ratio and sequential reaction model	2005	de Gouw et al. (2005)
4	NOAA aircraft data	Species ratio method	2007	Parrish et al. (2007)
5	NOAA aircraft data	Species ratio and sequential reaction model	2007	Warneke et al. (2007)
6	Beijing	Sequential reaction model	2008	Xie et al. (2008)
7	Beijing	Species ratio method	2011	Shao et al. (2011)
8	Beijing	Species ratio method	2012	Yuan et al. (2012)
9	Shanghai	Species ratio method	2013	Wang et al. (2013)
10	Heshan	Species ratio method	2016	Wang et al. (2016)
11	Beijing	Species ratio method	2016	Sun et al. (2016)
12	Beijing	Species ratio method	2018	Gao et al. (2018)
13	Heshan	Species ratio method	2019	He et al. (2019)
14	Shenzhen	Species ratio method	2019	Huang et al. (2019)
15	Beijing	Species ratio method	2021	Zhan et al. (2021)
16	Guangzhou	Species ratio method	2021	Fang et al. (2021)
17	Tianjin	Species ratio method	2022	Yang et al. (2022)
18	Beijing	Species ratio and sequential reaction model	2023	Wu et al. (2023a)
19	Handan	Species ratio method	2022	Wei et al. (2022)
20	Pune	Species ratio method	2022	Kalbande et al. (2022)
21	Tianjin	Species ratio method	2023	Liu et al. (2023a)
22	Tianjin and Guangzhou	Local parameter method	2023	Wang et al. (2023b)
23	Wuhan	Species ratio method	2021	Zheng et al. (2021)
24	Tianjin	Local parameter method	2022	Wang et al. (2022)

25	Jiaozhou	Species ratio method	2023	Wu et al. (2023b)
26	-	Isotopic hydrocarbon clock method	2000	Rudolph and Czuba (2000)
27	East Asia	Isotopic hydrocarbon clock method	2009	Saito et al. (2009)
28	Toronto	Isotopic hydrocarbon clock method	2016	Kornilova et al. (2016)
29	Guangzhou	Species ratio method	2023	Zou et al. (2023)

“Local parameter method” was defined that Δt was estimated based on the distributions of emission sources and wind directions around the receptor measure site.

Table S6. Primary initial ratios of reference species used in different publications.

Literature	T/B[a]	X/B[b]	E/X[c]	X/E[d]	E/O[e]	iB/P[f]	Methods	Time
de Gouw et al. (2005)	3.7	-	-	-	-	-	Based on observed data	-
Warneke et al. (2007)	4.25	-	-	-	-	-	Based on observed data	-
Yuan et al. (2012)	-	2.2	-	-	-	-	Based on observed data	00:00-05:00
Wang et al. (2013)	-	-	0.5	-	-	-	Based on emission inventory	-
Wang et al. (2016)	-	-	-	2.0	-	-	Based on source profiles	-
Sun et al. (2016)	-	-	-	1.8	-	-	Based on observed data	00:00-05:00
Gao et al. (2018)	-	-	-	0.39	1.32	-	Based on observed data	-
He et al. (2019)	-	-	0.62	-	-	-	Based on observed data	00:00-05:00
Han et al. (2020)	-	-	-	1.04	-	-	Based on observed data	00:00-06:00
Fang et al. (2021)	-	-	0.5	-	-	-	Based on observed data	00:00-04:00
Yang et al. (2022)	3.14	-	-	-	-	-	Based on observed data	20:00-05:00
Wu et al. (2023a)	-	-	-	2.47	-	-	Based on observed data	
Liu et al. (2023a)	-	-	0.22	-	-	-	Based on observed data	00:00-05:00
Kong et al. (2022)	-	-	0.23	-	-	-	Based on observed data	21:00-02:00
Li et al. (2021)	-	-	0.75	-	-	-	Based on observed data	03:00-07:00
Zou et al. (2021)	-	-	0.50	-	1.30	-	Based on observed data	19:00-06:00
Shao et al. (2011)	-	-	-	-	-	-	Based on observed NOx/NOy >80% data	-
Zou et al. (2023)	-	-	-	2.0	-	-	Based on summer observed data	20:00-06:00
Zou et al. (2023)	-	-	-	1.8	-	-	Based on autumn observed data	20:00-06:00

[a] denotes Toluene/Benzene; [b] denotes m,p-Xylene/Benzene; [c] denotes Ethylbenzene/m,p-Xylene; [d] denotes Ethylbenzene/m,p-Xylene; [e] denotes Ethylbenzene/o-Xylene; [f] denotes i-Butene/Propene

Table S7. Summary of relevant parameters for source analyses of OVOCs using the photochemical-age parameter method in publications.

City	Tracer species	Methods to determine parameters	Literature
Shenzhen	Benzene	linear least-squares fits	Zhu et al. (2021)
NEAQS data	Acetylene	linear least-squares fit	de Gouw et al. (2005)
Beijing and Shenzhen	Benzene	least-squares fit	Huang et al. (2020)
Beijing	Acetylene	least-squares fit	Yuan et al. (2012)
Heshan	CO	least-squares fit	Wang et al. (2016)
Wangdu	Benzene	linear least-squares fits	Han et al. (2019)
Guangzhou	Acetylene	linear least-squares fits	Wu et al. (2020)

Table S8. Summary of parameter values obtained utilizing a least-squares linear fit in the photochemical-age parameter method.

	ER_{ovoc}	$ER_{precursor}$	k_{ovoc}	$k_{precursor}$	$ER_{biogenic}$	[background]
	ppbv [ppbv C_2H_2]$^{-1}$		10^{-12} cm^{3}molecule^{-1}s^{-1}		ppbv [ppbv isoprene]$^{-1}$	pptv
Beijing (Huang et al., 2020)						
Methanol	16.95	3.04	0.94	3.12	1.92	3.95
Formaldehyde	3.14	9.39	9.7	8.15	1.34	1.25
Acetaldehyde	1.85	6.89	15	4.45	0.69	0.48
Acetone	1.09	4.26	0.17	4.76	0.63	1.36
MEK	0.72	3.89	1.22	1.26	0.14	0.08
Shenzhen (Huang et al., 2020)						
Methanol	16.43	8.42	0.94	7.96	1.24	1.01
Formaldehyde	1.14	15.69	9.7	8.63	0.8	0.24
Acetaldehyde	0.71	14.12	15	14.74	0.53	0.1

Acetone	1.51	13.31	0.17	14.51	0.64	0.81
MEK	1.16	8.97	1.22	9.51	0.14	0.06
NEAQS data (de Gouw et al., 2005)						
Acetaldehyde	0.83±0.07	6.9±0.9	15	2.3±0.4	0.063±0.004	150±10
Propanal	0.24±0.02	3±1	20	1.3±0.4	0.010±0.001	22±5
Acetone	1.2±0.2	1.6±0.5	0.17	4±3	0.23±0.01	960±40
MEK	0.26±0.02	1±2	1.22	7±2	0.031±0.001	31±5
Methanol	2.3±0.2	0	0.94	0	0.44±0.02	1280±70
Ethanol	0.96±0.04	0	3.2	0	0.022±0.005	90±10
Formic acid	0	2.1±0.5	0.4	6±3	0.26±0.03	150±90
Acetic acid	0.0±0.4	1.8±0.4	0.8	7±4	0.19±0.02	90±70
Beijing (Yuan et al., 2012)						
Formaldehyde	0.72±0.11	6.4	9.4	2.87	0.98±0.07	0.94±0.21
Acetaldehyde	0.72±0.05	3.45	15	2.41	0.17±0.03	0.29±0.10
Propanal	0.02±0.02	2.04	20	2.45	0.14± 0.01	0.31±0.03
n-Butanal	0.002±0.005	1.66	24	0.58	0.04±0.00	0.10±0.01
Acetone	0.57±0.05	1.47	0.17	1.05	0.18±0.03	1.98±0.09
MEK	0.31±0.01	0	1.22	0	0.07±0.01	0.06±0.04
Methanol	3.43±0.11	0	0.94	0	0.02 ± 0.11	5.76±0.37

Table S9. Summary of publications on estimation methods of consumed VOCs (i.e., CVOCs) and models used for their source analyses.

Literature	Publication Year	Calculation Methods	Apportionment Methods
Ma et al. (2022)	2022	Difference method	-
Gao et al. (2018)	2018	Difference method	-
Gu et al. (2023)	2023	Difference method	PMF
Zhan et al. (2021)	2021	Difference method	-
Chen et al. (2023)	2023	Difference method	-
Wang et al. (2013)	2013	Difference method	-
Liu et al. (2023a)	2023	Difference method	PMF
Wang et al. (2023b)	2023	Difference method	PMF/ME2-SR
Xie et al. (2008)	2008	Isoprene loss reference method	-
Wang et al. (2022)	2022	Difference method	PMF/ME2-SR
Wiedinmyer et al. (2001)	2001	Isoprene loss reference method	-
Kong et al. (2023)	2023	Difference method	PMF

Table S10. Summary of information related to VOC measured and initial concentrations, and chemical losses in the reviewed publications.

City	Study period	Season	Initial concentration calculated time (LT)	Numbers of species	TVOC conc. (ppbv)			CL rate [d] (%)
					OC [a]	IC [b]	CL [c]	
Beijing (Gao et al., 2018)	2013/03-2013/04	Spring	08:30-09:00 and 13:30-14:00	90	64.9	72.6	7.72	10.6
Qingdao (Gu et al., 2023)	2022/06-2022/08	Summer	06:00-19:00	89	19.8	45.4	45.1	69.1
Beijing (Zhan et al., 2021)	2019/08	Summer	-	51	11.2	14.6	3.40	23.3
Taipei (Chen et al., 2023)	2020/03-2020/05	Spring	07:00-17:00	54	27.6	31.8	4.21	13.2
Taipei (Chen et al., 2023)	2020/06-2020/08	Summer	07:00-17:00	54	22.0	30.3	8.29	27.3
Taipei (Chen et al., 2023)	2020/09-2020/11	Autumn	07:00-17:00	54	20.6	22.1	1.48	6.71
Taipei (Chen et al., 2023)	2020/12-2021/02	Winter	07:00-17:00	54	24.8	25.6	0.76	2.97
Tianjin (Liu et al., 2023a)	2020/04-2020/08	Spring-Summer	06:00-23:00	54	19.4	-	17.8	56.5
Beijing (Ma et al., 2022)	2019/01-2019/12	Year	00:00-23:00	56	18.6	24.5	6.90	28.2
Tianjin (Wang et al., 2023b)	2018	Year	-	-	21.4	24.3	2.90	11.9
Guangzhou (Wang et al., 2023b)	2020	Year	-	-	29.6	34.8	5.20	14.9
Shanghai (Wang et al., 2013)	2009	Year	08:00-18:00	-	26.4	35.4	9.00	25.4
Shanghai (Wang et al., 2013)	2010	Year	08:00-18:00	-	24.5	34.1	9.60	28.2
Chengdu (Kong et al., 2023)	2019	Spring	00:00-23:00	56	19.4	26.0	6.60	25.4
Chengdu (Kong et al., 2023)	2019	Summer	00:00-23:00	56	19.3	25.1	5.90	23.5
Chengdu (Kong et al., 2023)	2019	Autumn	00:00-23:00	56	23.5	26.6	3.10	11.7
Chengdu (Kong et al., 2023)	2019	Winter	00:00-23:00	56	33.6	35.9	2.30	6.41

[a] denotes observation concentrations; [b] denotes initial concentrations; [c] denotes chemical loss; [d] denotes the chemical loss rate (i.e., chemical loss/initial concentration).

Table S11. Summary of concentrations and percentages of the consumed VOC species in the reviewed publications.

City	Studied period	Season	Alkanes		Alkenes		Aromatic hydrocarbons		Alkyne		OVOCs		Halo-hydrocarbons	
			Conc. [a] (ppbv)	Per. [b] (%)	Conc. (ppbv)	Per. (%)	Conc. (ppbv)	Per. (%)	Conc. (ppbv)	Per. (%)	Conc. (ppbv)	Per. (%)	Conc. (ppbv)	Per. (%)
Beijing (Gao et al., 2018)	2013/03-2013/04	Spring	0.83	10.7	5.26	68.0	1.51	19.5	0.13	1.68	-		-	
Qingdao (Gu et al., 2023)	2022/06-2022/08	Summer	1.05	2.33	42.1	93.3	1.72	3.81	0.02	0.04	0.21	0.5	0.04	0.1
Beijing (Zhan et al., 2021)	2019/08	Summer	0.21	6.18	2.74	80.6	0.45	13.2	0.00	0.00	-		-	
Taipei (Chen et al., 2023)	2020/03-2020/05	Spring	0.53	12.8	2.52	61.2	1.03	25.1	0.04	0.85	-		-	
Taipei (Chen et al., 2023)	2020/06-2020/08	Summer	0.55	6.61	6.51	78.6	1.20	14.5	0.03	0.30	-		-	
Taipei (Chen et al., 2023)	2020/09-2020/11	Autumn	0.19	12.5	0.91	61.0	0.39	25.8	0.01	0.67	-		-	
Taipei (Chen et al., 2023)	2020/12-2021/02	Winter	0.12	15.7	0.42	55.4	0.21	27.5	0.01	1.33	-		-	
Tianjin (Liu et al., 2023a)	2020/04-2020/08	Spring/Summer	1.43	8.21	15.2	87.3	0.75	4.31	0.03	0.17	-		-	
Chengdu (Kong et al., 2023)	2019/01-2019/12	Spring	0.60	9.23	5.00	76.9	0.90	13.8	0.00	0.00	-		-	
Chengdu (Kong et al., 2023)	2019/01-2019/12	Summer	0.70	11.9	3.40	57.6	1.80	30.5	0.00	0.00	-		-	
Chengdu (Kong et al., 2023)	2019/01-2019/12	Autumn	0.50	16.1	1.40	45.2	1.20	38.7	0.00	0.00	-		-	
Chengdu (Kong et al., 2023)	2019/01-2019/12	Winter	0.50	22.7	1.30	59.1	0.40	18.2	0.00	0.00	-		-	

[a] denotes consumed concentrations; [b] denotes percentages of consumed concentrations of different species in total consumed concentrations.

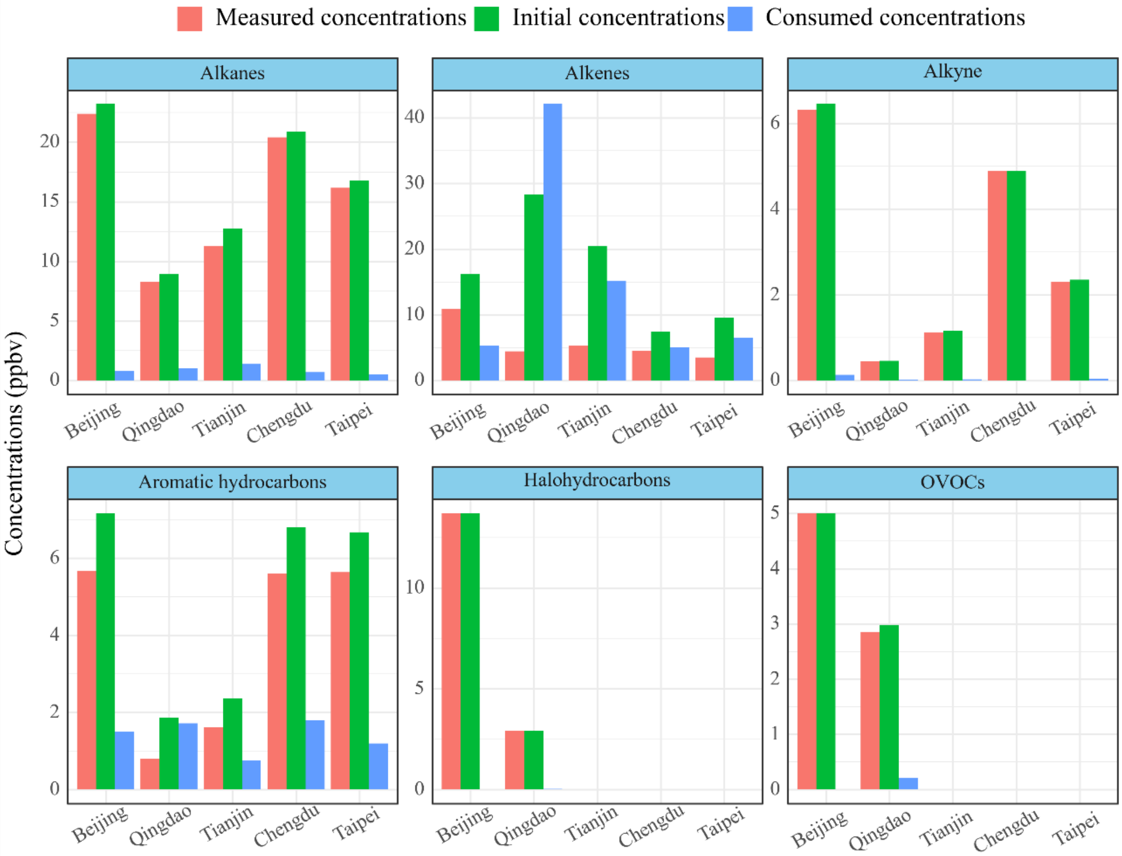

Figure S1. The measured and initial concentrations of VOC groups, and their consumed concentrations in Beijing (Gao et al., 2018; Zhan et al., 2021), Qingdao (Gu et al., 2023), Tianjin (Liu et al., 2023a), Chengdu (Kong et al., 2023), and Taipei (Chen et al., 2023) in the reviewed publications. The data of Beijing was the average value from the two publications.

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