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Supplement of

Non-OH chemistry in oxidation flow reactors for the study of atmospheric chemistry systematically examined by modeling

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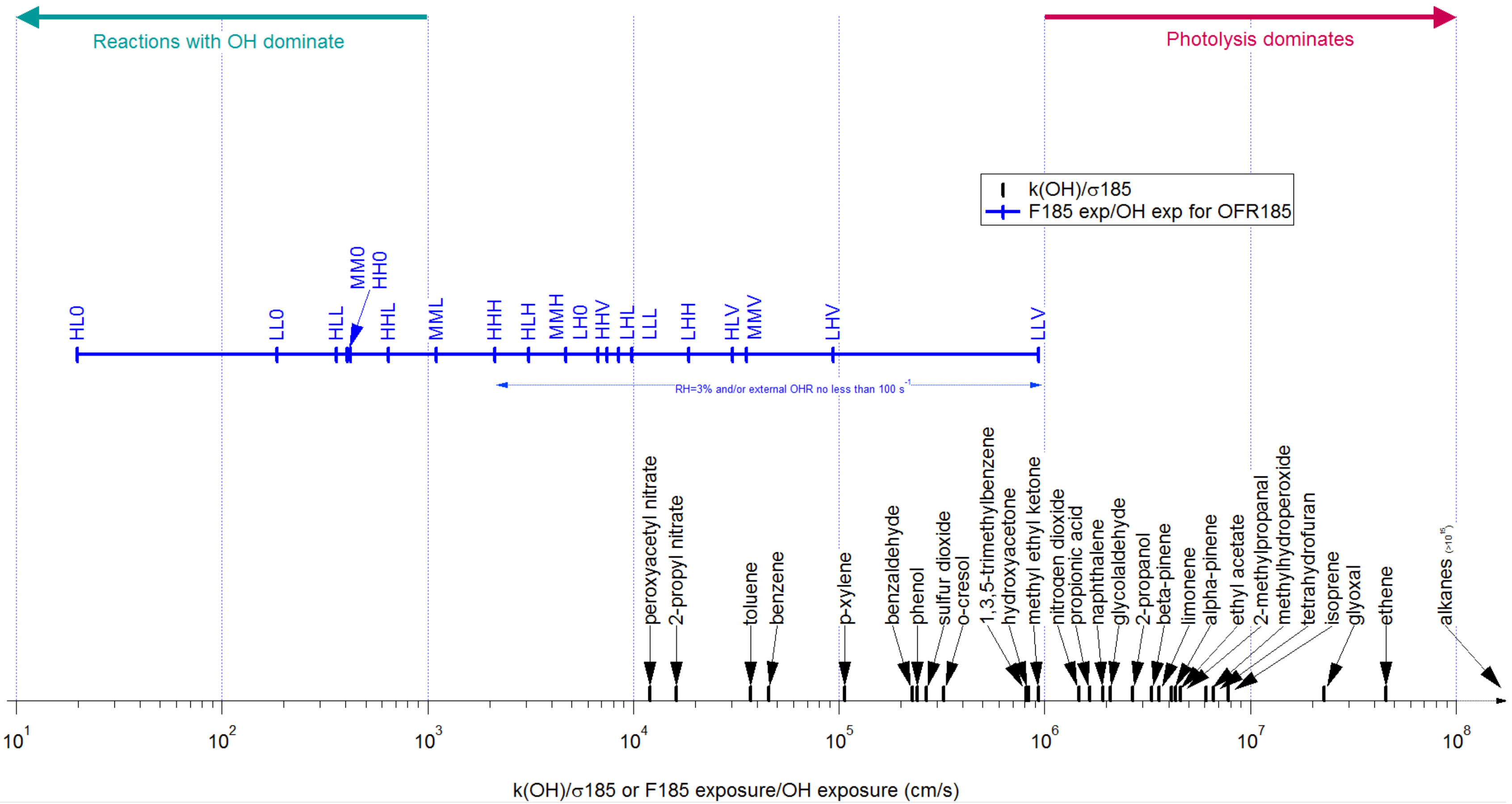

Figure S1. Ratios between rate constants of several species of atmospheric interest with OH and their photoabsorption cross-sections at 185 nm (black markers) and ratios between 185 nm-photon (F185) and OH exposures for OFR185 (blue). The former are also equal to F185 exposure/OH exposure at which photons at 185 nm and OH consume species equally. Ratios between 185 nm photon and OH exposures in typical OFR cases are shown by markers. Typical conditions corresponding to these ratios' highest values are shown and their ranges are denoted by dashed arrows. The reaction of the considered species with OH is preponderant over photolysis at 185 nm at a certain value of F185 exposure/OH exposure, when this value is located on the left of the considered species' black marker, as the turquoise solid arrow on the top indicates. The reverse is true when this value is on the right, as the carmine solid arrow on the top indicates.

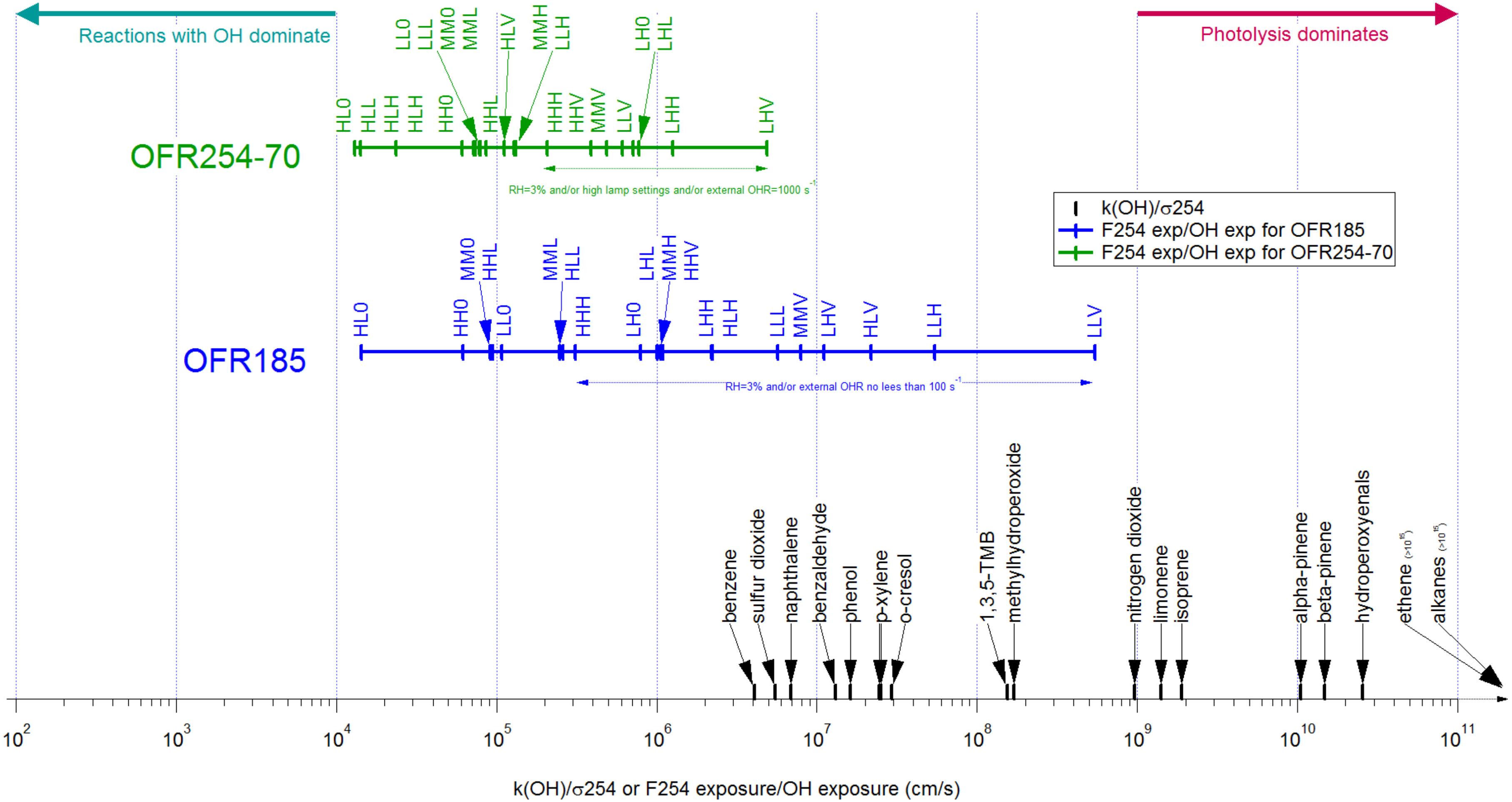

Figure S2. Same as Fig. S1, but for ratios of rate constants with OH and photoabsorption cross-sections at 254 nm and F254 exposure/OH exposure for OFR185 and OFR254-70.

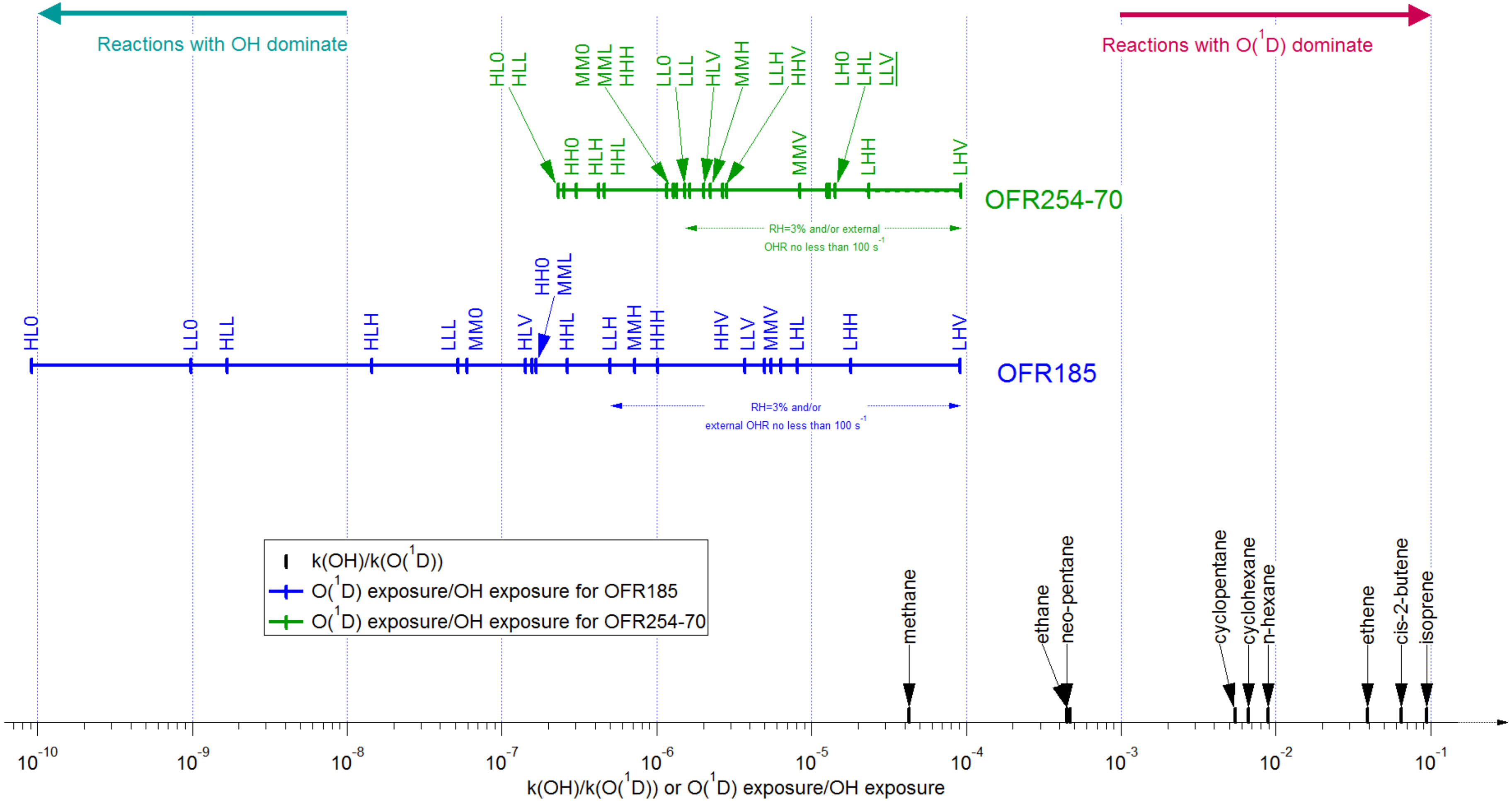

Figure S3. Same as Fig. S1, but for ratios of rate constants with OH and O(^{1}D) and O(^{1}D) exposure/OH exposure for OFR185 and OFR254-70.

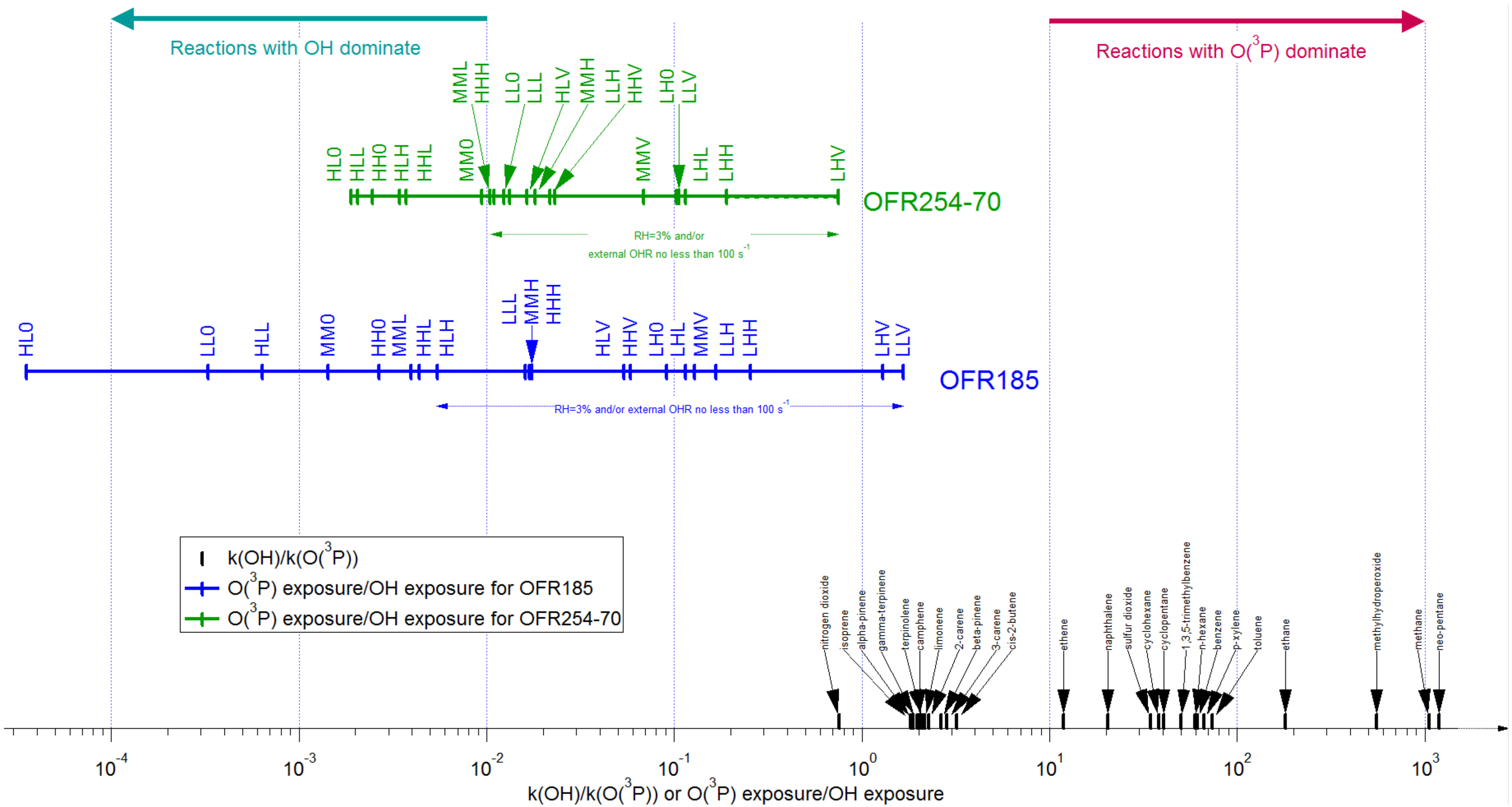

Figure S4. Same as Fig. S1, but for ratios of rate constants with OH and O(^{3}P) and O(^{3}P) exposure/OH exposure for OFR185 and OFR254-70.

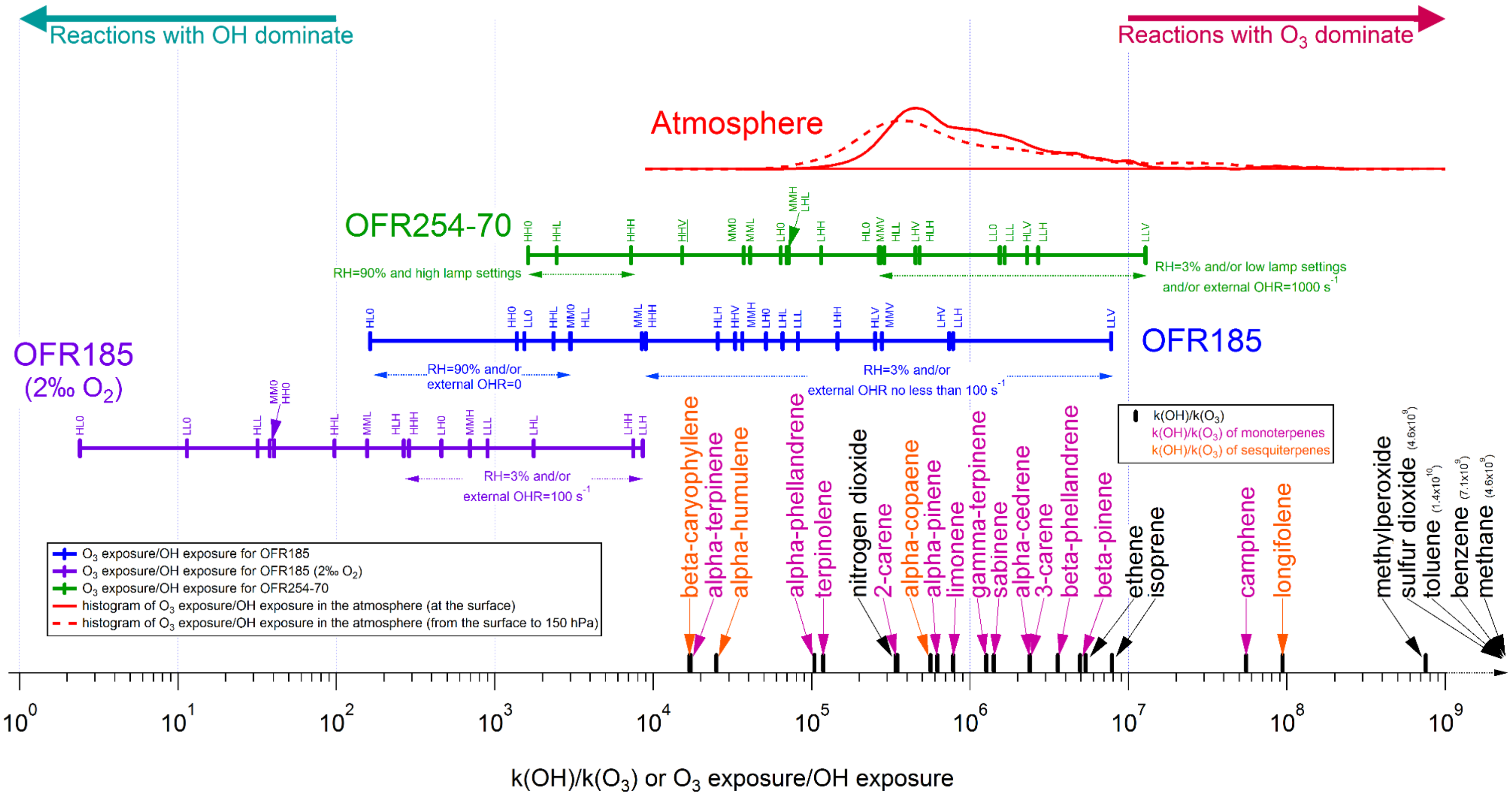

Figure S5. Same as Fig. S1, but for ratios of rate constants with OH and O_3 of species of atmospheric interest and O_3 exposure/OH exposure for OFR185 (blue), OFR185 with 0.2% O_2 (purple), OFR254-70 (dark green), and chamber studies (orange), and in the atmosphere (red).
Species names corresponding to ratios between rate constants of OH and of O_3 with monoterpenes, sesquiterpenes, and other species are in magenta, dark orange, and black, respectively. O_3 exposure/OH exposure at the Earth's surface (solid line) and throughout the column from the surface to a height with a pressure of 150 hPa (dashed line) in the atmosphere are shown by histograms, as simulated by the GISS ModelE2.

Table S1. Photoabsorption cross-sections (in cm^2 molecule^{-1}) of several species of atmospheric interest at 185 and 254 nm and rate constants (in cm^3 molecule^{-1} s^{-1}) of these species with OH at room temperature (298 K).

Species	σ(185)	Ref	σ(254)	Ref	k(OH)	Ref
isoprene	1.28E-17	(Keller-Rudek et al., 2015)	5.28E-20	(Keller-Rudek et al., 2015)	1.00E-10	(Atkinson and Arey, 2003)
α-pinene	1.27E-17	(Keller-Rudek et al., 2015)	~5E-21	(Keller-Rudek et al., 2015)[*1]	5.23E-11	(Atkinson and Arey, 2003)
β-pinene	2.25E-17	(Keller-Rudek et al., 2015)	~5E-21	(Keller-Rudek et al., 2015)[*2]	7.43E-11	(Atkinson and Arey, 2003)
limonene	4.58E-17	(Keller-Rudek et al., 2015)	1.16E-19	(Keller-Rudek et al., 2015)	1.64E-10	(Atkinson and Arey, 2003)
sulfur dioxide	3.47E-18	(Keller-Rudek et al., 2015)	1.67E-19	(Keller-Rudek et al., 2015)	9.20E-13	(Sander et al., 2011)
nitrogen dioxide	6.88E-18	(Keller-Rudek et al., 2015)	1.05E-20	(Keller-Rudek et al., 2015)	1.01E-11	(Sander et al., 2011)
benzene	2.68E-17	(Keller-Rudek et al., 2015)	3.00E-19	(Keller-Rudek et al., 2015)	1.22E-12	(Atkinson and Arey, 2003)
toluene	1.52E-16	(Keller-Rudek et al., 2015)	2.29E-19	(Keller-Rudek et al., 2015)	5.63E-12	(Atkinson and Arey, 2003)
benzaldehyde	~5.3E-17	this work[*3]	9.20E-19	(Keller-Rudek et al., 2015)	1.20E-11	(Trost et al., 1997)
o-cresol	~1.3E-16	this work[*3]	1.43E-18	(Keller-Rudek et al., 2015)	4.20E-11	(Trost et al., 1997)
phenol	~1.1E-16	this work[*3]	1.63E-18	(Keller-Rudek et al., 2015)	2.63E-11	(Atkinson and Arey, 2003)
p-xylene	1.34E-16	(Keller-Rudek et al., 2015)	5.70E-19	(Keller-Rudek et al., 2015)	1.43E-11	(Atkinson and Arey, 2003)
1,3,5-trimethylbenzene	6.96E-17	(Keller-Rudek et al., 2015)	3.68E-19	(Keller-Rudek et al., 2015)	5.67E-11	(Atkinson and Arey, 2003)
naphthalene	1.20E-17	(Halasinski et al., 2005)	3.33E-18	(Ferguson et al., 1957)	2.30E-11	(Atkinson and Arey, 2003)
methylhydroperoxide	~9E-19	(Keller-Rudek et al., 2015)[*4]	3.23E-20	(Keller-Rudek et al., 2015)	3.80E-12	(Sander et al., 2011)
hydroperoxyenals	N/A	N/A	~2E-21	(Wolfe et al., 2012)[*5]	~5.1E-11	(Wolfe et al., 2012)[*6]
2-propanol	2.16E-18	(Keller-Rudek et al., 2015)	0	N/A	5.80E-12	(Atkinson and Arey, 2003)
glyoxal	4.80E-19	(Keller-Rudek et al., 2015)[*7]	1.59E-20	(Keller-Rudek et al., 2015)	1.10E-11	(Atkinson and Arey, 2003)
2-methylpropanal	5.71E-18	(Keller-Rudek et al., 2015)	1.22E-20	(Keller-Rudek et al., 2015)	2.60E-11	(Atkinson and Arey, 2003)
glycolaldehyde	3.85E-18	(Keller-Rudek et al., 2015)	3.76E-20	(Keller-Rudek et al., 2015)	8.00E-12	(Ammann et al., 2015)
methyl ethyl ketone	1.31E-18	(Keller-Rudek et al., 2015)	3.09E-20	(Keller-Rudek et al., 2015)	1.22E-12	(Atkinson and Arey, 2003)
hydroxyacetone	5.40E-18	(Keller-Rudek et al., 2015)	5.07E-20	(Keller-Rudek et al., 2015)	4.50E-12	(Ammann et al., 2015)
ethyl acetate	4.21E-19	(Keller-Rudek et al., 2015)	5.00E-22	(Keller-Rudek et al., 2015)[*8]	1.82E-12	(El Boudali et al., 1996)
propionic acid	7.25E-19	(Keller-Rudek et al., 2015)	7.11E-21	(Keller-Rudek et al., 2015)	1.20E-12	(Ammann et al., 2015)
tetrahydrofuran	2.27E-18	(Keller-Rudek et al., 2015)	0	N/A	1.50E-11	(Atkinson, 1986)
2-propyl nitrate	1.79E-17	(Keller-Rudek et al., 2015)	4.86E-20	(Keller-Rudek et al., 2015)	2.90E-13	(Atkinson and Arey, 2003)

peroxyacetyl nitrate	6.20E-18	(Sander et al., 2011)[*9]	1.00E-19	(Sander et al., 2011)	7.50E-14	(Tsalkani et al., 1988)
ethene	1.87E-19	(Keller-Rudek et al., 2015)	0	N/A	8.52E-12	(Atkinson and Arey, 2003)
alkanes	0	N/A	0	N/A	~1E-12	(Atkinson and Arey, 2003)

*1: approximate average value between 245 and 250 nm
*2: approximate average value between 245 and 250 nm
*3: estimate based on quantum chemical calculations. See details below.
*4: extrapolation from the data between 210 and 280 nm, whose logarithm manifests a good linear wavelength-dependence
*5: value of a proxy, (*E*)-2-hexanal
*6: value of a proxy, C_6-hydroperoxyenal
*7: value at 193 nm
*8: value at 252 nm
*9: linear extrapolation from the data between 196–206 nm

Table S2. Rate constants (in cm^3 molecule^{-1} s^{-1}) of several species of atmospheric interest with O(^{1}D), O(^{3}P), and OH at room temperature (298 K).

Species	k(O(^{1}D))	Ref	k(O(^{3}P))	Ref	k(OH)	Ref
sulfur dioxide	N/A	N/A	2.67E-14	(Atkinson et al., 1997)	9.19E-13	(Sander et al., 2011)
nitrogen dioxide	N/A	N/A	1.34E-11	(Sander et al., 2011)	1.01E-11	(Sander et al., 2011)
methane	1.50E-10	(Ammann et al., 2015)	6.12E-18	(Cohen and Westberg, 1991)	6.40E-15	(Atkinson and Arey, 2003)
ethane	5.30E-10	(Michaud et al., 1974)	1.38E-15	(Cohen and Westberg, 1991)	2.48E-13	(Atkinson and Arey, 2003)
neo-pentane	1.84E-09	(Pitts et al., 1974)	6.91E-16	(Cohen and Westberg, 1991)	8.25E-13	(Atkinson and Arey, 2003)
cyclopentane	9.05E-10	(Michaud et al., 1974)	1.23E-13	(Cohen and Westberg, 1991)	4.97E-12	(Atkinson and Arey, 2003)
n-hexane	5.80E-10	(Dillon et al., 2008)	8.69E-14	(Cohen and Westberg, 1991)	5.20E-12	(Atkinson and Arey, 2003)
cyclohexane	1.05E-09	(Michaud et al., 1974)	1.83E-13	(Cohen and Westberg, 1991)	6.97E-12	(Atkinson and Arey, 2003)
ethene	2.19E-10	(Kajimoto and Fueno, 1979)	7.25E-13	(Cvetanović, 1987)	8.52E-12	(Atkinson and Arey, 2003)
cis-2-butene	8.70E-10	(Kajimoto and Fueno, 1979)	1.76E-11	(Cvetanović, 1987)	5.64E-11	(Atkinson and Arey, 2003)
methylhydroperoxide	N/A	N/A	1.00E-14	(Baulch et al., 1994)	5.50E-12	(Atkinson and Arey, 2003)
benzene	N/A	N/A	1.99E-14	(Cvetanović, 1987)	1.22E-12	(Atkinson and Arey, 2003)
toluene	N/A	N/A	7.63E-14	(Baulch et al., 1994)	5.63E-12	(Atkinson and Arey, 2003)
p-xylene	N/A	N/A	2.15E-13	(Baulch et al., 1994)	1.43E-11	(Atkinson and Arey, 2003)
1,3,5-trimethylbenzene	N/A	N/A	1.13E-12	(Cvetanović, 1987)	5.67E-11	(Atkinson and Arey, 2003)
naphthalene	N/A	N/A	1.13E-12	(Frerichs et al., 1990)	2.30E-11	(Atkinson and Arey, 2003)
isoprene	1.06E-09	(Kajimoto and Fueno, 1979)	5.52E-11	(Cvetanović, 1987)	1.00E-10	(Atkinson and Arey, 2003)
α-pinene	N/A	N/A	2.79E-11	(Luo et al., 1996)	5.23E-11	(Atkinson and Arey, 2003)
β-pinene	N/A	N/A	2.80E-11	(Luo et al., 1996)	7.43E-11	(Atkinson and Arey, 2003)
3-carene	N/A	N/A	3.12E-11	(Luo et al., 1996)	8.80E-11	(Atkinson and Arey, 2003)
2-carene	N/A	N/A	3.54E-11	(Luo et al., 1996)	8.00E-11	(Atkinson and Arey, 2003)
camphene	N/A	N/A	2.60E-11	(Luo et al., 1996)	5.30E-11	(Atkinson and Arey, 2003)
limonene	N/A	N/A	7.60E-11	(Luo et al., 1996)	1.64E-10	(Atkinson and Arey, 2003)
γ-terpinene	N/A	N/A	9.00E-11	(Luo et al., 1996)	1.77E-10	(Atkinson and Arey, 2003)
terpinolene	N/A	N/A	1.07E-10	(Luo et al., 1996)	2.25E-10	(Atkinson and Arey, 2003)
2-propanol	N/A	N/A	6.64E-14	(Herron, 1988)	5.80E-12	(Atkinson and Arey, 2003)
2-methylpropanal	N/A	N/A	1.15E-12	(Herron, 1988)	2.60E-11	(Atkinson and Arey, 2003)

methyl ethyl ketone	N/A	N/A	1.09E-14	(Herron, 1988)	1.22E-12	(Atkinson and Arey, 2003)
ethyl acetate	N/A	N/A	5.59E-15	(Herron, 1988)	1.82E-12	(El Boudali et al., 1996)
tetrahydrofuran	N/A	N/A	2.36E-13	(Herron, 1988)	1.50E-11	(Atkinson, 1986)
ethyl nitrate	N/A	N/A	7.02E-15	(Salter and Thrush, 1977)	1.80E-13	(Atkinson and Arey, 2003)
formaldehyde	N/A	N/A	1.70E-13	(Herron, 1988)	9.37E-12	(Atkinson and Arey, 2003)

Table S3. Rate constants (in cm^3 molecule^{-1} s^{-1}) of several species of atmospheric interest with O_3, and OH at room temperature (298 K).

Species	k(OH)	Ref	k(O_3)	Ref
isoprene	1.00E-10	(Atkinson and Arey, 2003)	1.27E-17	(Atkinson and Arey, 2003)
camphene	5.30E-11	(Atkinson and Arey, 2003)	9.60E-19	(Atkinson and Arey, 2003)
2-carene	8.00E-11	(Atkinson and Arey, 2003)	2.30E-16	(Atkinson and Arey, 2003)
3-carene	8.80E-11	(Atkinson and Arey, 2003)	3.70E-17	(Atkinson and Arey, 2003)
limonene	1.64E-10	(Atkinson and Arey, 2003)	2.10E-16	(Atkinson and Arey, 2003)
α-phellandrene	3.13E-10	(Atkinson and Arey, 2003)	3.00E-15	(Atkinson and Arey, 2003)
β-phellandrene	1.68E-10	(Atkinson and Arey, 2003)	4.70E-17	(Atkinson and Arey, 2003)
α-pinene	5.23E-11	(Atkinson and Arey, 2003)	8.40E-17	(Atkinson and Arey, 2003)
β-pinene	7.43E-11	(Atkinson and Arey, 2003)	1.50E-17	(Atkinson and Arey, 2003)
sabinene	1.17E-10	(Atkinson and Arey, 2003)	8.30E-17	(Atkinson and Arey, 2003)
α-terpinene	3.63E-10	(Atkinson and Arey, 2003)	2.10E-14	(Atkinson and Arey, 2003)
γ-terpinene	1.77E-10	(Atkinson and Arey, 2003)	1.40E-16	(Atkinson and Arey, 2003)
terpinolene	2.25E-10	(Atkinson and Arey, 2003)	1.90E-15	(Atkinson and Arey, 2003)
α-cedrene	6.70E-11	(Atkinson and Arey, 2003)	2.80E-17	(Atkinson and Arey, 2003)
α-copaene	9.00E-11	(Atkinson and Arey, 2003)	1.60E-16	(Atkinson and Arey, 2003)
β-caryophyllene	1.97E-10	(Atkinson and Arey, 2003)	1.16E-14	(Atkinson and Arey, 2003)
α-humulene	2.93E-10	(Atkinson and Arey, 2003)	1.17E-14	(Atkinson and Arey, 2003)
longifolene	4.70E-11	(Atkinson and Arey, 2003)	5.00E-19	(Atkinson and Arey, 2003)
methane	6.40E-15	(Atkinson and Arey, 2003)	1.40E-24	(Schubert et al., 1956)
ethene	8.52E-12	(Atkinson and Arey, 2003)	1.59E-18	(Atkinson and Arey, 2003)
benzene	1.22E-12	(Atkinson and Arey, 2003)	1.72E-22	(Toby et al., 1985)
toluene	5.63E-12	(Atkinson and Arey, 2003)	3.90E-22	(Toby et al., 1985)
methylperoxide	5.50E-12	(Atkinson and Arey, 2003)	7.30E-21	(Chen and Wang, 2006)
sulfur dioxide	9.20E-13	(Sander et al., 2011)	2.00E-22	(Sander et al., 2011)
nitrogen dioxide	1.01E-11	(Sander et al., 2011)	2.97E-17	(Sander et al., 2011)

Table S4. Summary of the previous studies using OFRs. In case of multiple experiments with a certain source in a certain study, only the most (low water mixing ratio and high external OH reactivity) and the least (high water mixing ratio and low external OH reactivity) pathological cases are shown. Source, external OH reactivity (Ext. OHR), OH exposure (OH exp.), and relative humidity (RH) in each experiment are collected from the literature. Exposure ratios and percentages of the rate of a type of reactions [r(X), X=185 nm photons, 254 nm photons, $O(^1D)$, $O(^3P)$, and O_3] in the sum of the rates of these reactions and those with OH [r(X)+r(OH)] are estimated by our model. Photolysis at 185 and 254 nm is considered as non-tropospheric reactions (NTR). An example of the improvement of study using OFR is also shown for comparison.

Study	Source type	Source mixing ratio (ppb)	Ext. OHR (s^{-1})	OH exp. (molec cm^{-3} s)	RH (%)	Examined species	F185 exp./OH exp. (cm/s)	r(185) /(r(185) +r(OH)) (%)	F254 exp./OH exp. (cm/s)	r(254) /(r(254) +r(OH)) (%)	$O(^1D)$ exp. /OH exp.	$r(O(^1D))$ /($r(O(^1D))$ +r(OH)) (%)[*8]	$O(^3P)$ exp. /OH exp.	$r(O(^3P))$ /($r(O(^3P))$ +r(OH)) (%)	O_3 exp. /OH exp.	$r(O_3)$ /($r(O_3)$ +r(OH)) (%)[*9]	r(non-OH) /(r(total)) (%)	r(NTR) /(r(total)) (%)
Kang et al. 2011	α-pinene	39	49	2.8E+11	3	α-pinene			3.1E+06	0.03	7.7E-06	0.02	5.3E-02	2.88	1.8E+05	23.45	26.38	0.02
				2.3E+12	42				3.3E+05	0.00	6.0E-07	0.00	4.2E-03	0.23	1.7E+04	2.81	3.04	0.00
	m-xylene	170	94	2.4E+11	4	m-xylene			4.3E+06	8.47	1.0E-05	0.05	7.3E-02	0.13	2.1E+05	0.01	8.62	8.46
				2.4E+12	48				5.6E+05	1.21	8.4E-07	0.00	5.8E-03	0.01	1.4E+04	0.00	1.22	1.21
	p-xylene	180	62	2.1E+11	4	p-xylene			2.6E+06	9.58	6.7E-06	0.05	4.6E-02	0.06	2.5E+05	0.02	9.68	9.57
				1.6E+12	32				5.4E+05	2.11	1.0E-06	0.01	7.2E-03	0.01	2.6E+04	0.00	2.13	2.11
	mixture	*1	88	1.8E+11	3	α-pinene			5.8E+06	0.06	1.5E-05	0.03	1.0E-01	5.32	2.9E+05	32.40	37.81	0.04
						m-xylene				11.23		0.06		0.17		0.01	11.42	11.20
						p-xylene				18.88		0.10		0.14		0.02	19.05	18.84
				2.3E+12	44	α-pinene			5.6E+05	0.01	8.7E-07	0.00	6.0E-03	0.75	1.5E+04	2.41	3.13	0.01
						m-xylene				1.19		0.00		0.01		0.00	1.21	1.19
						p-xylene				2.17		0.01		0.01		0.00	2.19	2.17
Lambe et al. 2011	n-decane	330	87	1.6E+11	30	n-decane			1.7E+05	0.00	1.2E-06	0.12	8.6E-03	0.00	4.1E+05	0.00	0.12	0.00
		102	27	2.5E+12	40				1.5E+05	0.00	8.7E-07	0.09	6.0E-03	0.00	2.2E+04	0.00	0.09	0.00
	isoprene	330	792	1.6E+11	30	isoprene			1.7E+06	0.09	1.2E-05	0.01	8.0E-02	4.48	3.9E+05	4.71	8.88	0.08
				2.5E+12	40				2.1E+06	0.11	9.5E-06	0.01	6.6E-02	3.74	5.1E+04	0.65	4.45	0.11
	α-pinene	50	63	1.6E+11	30	α-pinene			1.3E+05	0.00	9.5E-07	0.00	6.6E-03	0.36	4.1E+05	40.73	41.10	0.00
				2.5E+12	40				2.0E+05	0.00	1.1E-06	0.00	7.9E-03	0.44	2.1E+04	3.43	3.87	0.00
	β-pinene	50	89	1.6E+11	30	β-pinene			1.8E+05	0.00	1.3E-06	0.00	8.7E-03	0.54	4.1E+05	7.61	8.07	0.00
				2.5E+12	40				2.4E+05	0.00	1.3E-06	0.00	9.3E-03	0.58	2.1E+04	0.41	0.99	0.00
	toluene	80	11	1.6E+11	30	toluene			5.4E+04	0.24	3.9E-07	0.01	2.7E-03	0.00	4.2E+05	0.00	0.25	0.24
				2.5E+12	40				1.2E+05	0.53	7.5E-07	0.01	5.2E-03	0.01	2.2E+04	0.00	0.55	0.53
	m-xylene	103	57	1.6E+11	30	m-xylene			1.2E+05	0.27	8.8E-07	0.00	6.1E-03	0.01	4.1E+05	0.02	0.30	0.27
		86	48	2.5E+12	40				1.7E+05	0.38	1.0E-06	0.00	7.1E-03	0.01	2.2E+04	0.00	0.40	0.38
	1,3,5-trimethyl-benzene	150	204	1.6E+11	30	1,3,5-trimethyl-benzene			3.9E+05	0.26	2.8E-06	0.00	1.9E-02	4.55	4.1E+05	0.01	4.80	0.25
		120	163	2.5E+12	40				3.7E+05	0.25	1.9E-06	0.00	1.3E-02	3.22	1.9E+04	0.00	3.45	0.24
Klems et al. 2015	dodecanoic acid	400	123[*4]	1.7E+09[*5]	3	dodecanoic acid			1.6E+07	0.36	5.2E-06	0.04	4.3E-02	0.06	1.5E+04	0.00	0.46	0.36
Tkacik et al. 2014	tunnel air	*2	~300	7.4E+10	42[*6]	toluene[*7]	9.8E+03	20.97	1.5E+06	5.86	2.5E-07	0.00	1.0E-02	0.01	1.8E+04	0.00	24.69	24.67
		*3	~100	2.4E+12	42[*6]		1.3E+03	3.48	1.5E+05	0.60	1.6E-07	0.00	2.7E-03	0.00	3.8E+03	0.00	4.04	4.04
FLAME-3	wood smoke		~250	2.5E+11[*5]	22[*6]	benzene[*7]	2.6E+04	36.31	4.4E+06	51.97	1.7E-06	0.14	4.1E-02	0.07	1.6E+05	0.00	62.32	62.25
						α-pinene[*7]		0.63		0.04		0.00		2.15		20.32	22.10	0.52
BEACHON	ambient air		~15	2.1E+12[*5]	63[*6]	α-pinene[*7]	8.8E+02	0.02	1.5E+05	0.00	1.3E-07	0.00	2.8E-03	0.15	6.3E+03	1.00	1.17	0.02
SOAS			~20	1.4E+12[*5]	83[*6]	isoprene[*7]	8.1E+02	0.01	1.5E+05	0.01	5.7E-08	0.00	1.4E-03	0.08	5.4E+03	0.07	0.16	0.02
CalNex			~25	8.8E+11[*5]	43[*6]	toluene[*7]	1.1E+03	2.85	2.0E+05	0.82	1.2E-07	0.00	3.1E-03	0.00	1.2E+04	0.00	3.63	3.62
Improvement for FLAME-3	wood smoke		~50	8.7E+11[*5]	22[*6]	benzene[*7]	3.8E+03	7.72	4.8E+05	10.53	6.2E-07	0.05	1.0E-02	0.02	2.2E+04	0.00	16.81	16.76
								0.09		0.00		0.00		0.53		3.38	3.96	0.09

*1: 37 ppb α-pinene, 46 ppb m-xylene, and 47 ppb p-xylene

*2: 785 ppb NO_x, 1.9 ppm CO, and VOC of an OH reactivity of 49.7 s^{-1}, estimated from a linear CO-VOC relationship [VOC of 26.1 s^{-1} OH reactivity per ppm CO (Borbon et al., 2013)]

*3: 310 ppb NO_x, 0.2 ppm CO, and VOC of an OH reactivity of 5.2 s^{-1}, according to the same linear relationship

*4: estimated according to the rate constant of dodecane reported in Atkinson and Arey (2003)

*5: calculated by our model

*6: average value

*7: a typical species in source, not the only component

*8: rate constants of reactions of examined species with $O(^1D)$ that are not available are assumed to be 10^{-9} cm^3 molecule s^{-1}

*9: rate constants of reactions of n-decane and alkylbenzenes with O_3 are taken from their upper limits reported in Atkinson and Arey (2003)

Table S5. Percentage of non-OH fate of α-pinene and toluene in the "corner" cases (highest and lowest water mixing ratio, lamp setting, and external OH reactivity) in OFR185, OFR254-70, and OFR254-7. The cases with 0 external OH reactivity actually show non-OH VOC consumption at external OH reactivity very close but not equal to 0.

	OFR185		OFR254-70		OFR254-7	
Case	α-pinene	toluene	α-pinene	toluene	α-pinene	toluene
LL0	0.4	0.1	81.9	0.1	55.7	0.0
L"L"0	1.5	0.3	65.7	0.1	32.3	0.1
LH0	13.9	2.4	19.9	0.4	4.6	0.2
HL0	0.0	0.0	44.0	0.0	12.9	0.0
H"L"0	0.1	0.0	21.4	0.0	4.2	0.0
HH0	0.6	0.2	0.6	0.0	0.1	0.0
LLV	95.1	77.4	97.4	0.6	98.9	2.8
L"L"V	93.6	71.9	94.0	0.9	97.1	4.2
LHV	68.2	24.0	63.7	3.0	72.1	8.8
HLV	40.6	12.2	87.2	0.1	91.3	0.3
H"L"V	36.6	10.6	68.4	0.1	73.0	0.4
HHV	11.2	3.1	5.6	0.1	11.1	0.7

Table S6. Photoabsorption cross-sections (in cm^2 $molecule^{-1}$) of several possible SOA components at 185 and 254 nm and number of photolysis generations of these species in the case of high H_2O, high UV, and high OHR_{ext} (Case HHH). Numbers of photolysis generations in OFR no less than 0.1 are in bold, and those no less than 1 are highlighted in gray cell. Ambient photolysis generation numbers corresponding to the same photochemical age as Case HHH are also shown for comparison.

Species	σ(185)	Ref	σ(254)	Ref	Number of photolysis generations		
					185 nm	254 nm	Ambient
sulfuric acid	<1E-19	(Keller-Rudek et al., 2015)	<1E-21	(Keller-Rudek et al., 2015)	<1.8E-03	<1.5E-03	0
nitric acid	1.71E-17	(Keller-Rudek et al., 2015)	1.95E-20	(Keller-Rudek et al., 2015)	**0.31**	2.9E-02	7.1
benzaldehyde	5.30E-17	this work*1	9.20E-19	(Keller-Rudek et al., 2015)	**0.95**	**1.4**	7700
o-cresol	1.30E-16	this work*1	1.43E-18	(Keller-Rudek et al., 2015)	**2.3**	**2.1**	0
phenol	1.10E-16	this work*1	1.63E-18	(Keller-Rudek et al., 2015)	**2.0**	**2.4**	0
naphthalene	1.20E-17	(Halasinski et al., 2005)	3.33E-18	(Ferguson et al., 1957)	**0.22**	**5.0**	0
methylhydroperoxide	9.00E-19	(Keller-Rudek et al., 2015)*2	3.23E-20	(Keller-Rudek et al., 2015)	1.6E-02	4.8E-02	57
2-propanol	2.16E-18	(Keller-Rudek et al., 2015)	0	N/A	3.9E-02	0	0
glyoxal	4.80E-19	(Keller-Rudek et al., 2015)*3	1.59E-20	(Keller-Rudek et al., 2015)	8.6E-03	2.4E-02	640
2-methylpropanal	5.71E-18	(Keller-Rudek et al., 2015)	1.22E-20	(Keller-Rudek et al., 2015)	**0.10**	1.8E-02	510
glycolaldehyde	3.85E-18	(Keller-Rudek et al., 2015)	3.76E-20	(Keller-Rudek et al., 2015)	6.9E-02	5.6E-02	91
methyl ethyl ketone	1.31E-18	(Keller-Rudek et al., 2015)	3.09E-20	(Keller-Rudek et al., 2015)	2.4E-02	4.6E-02	40
hydroxyacetone	5.40E-18	(Keller-Rudek et al., 2015)	5.07E-20	(Keller-Rudek et al., 2015)	9.7E-02	7.6E-02	34
ethyl acetate	4.21E-19	(Keller-Rudek et al., 2015)	5.00E-22	(Keller-Rudek et al., 2015)*4	7.6E-03	7.5E-04	0
pentanoic acid	1.44E-18	(Keller-Rudek et al., 2015)	3.00E-21	(Keller-Rudek et al., 2015)	2.6E-02	4.5E-03	0
tetrahydrofuran	2.27E-18	(Keller-Rudek et al., 2015)	0	N/A	4.1E-02	0	0
alkanes	0	N/A	0	N/A	0	0	0
2-propyl nitrate	1.79E-17	(Keller-Rudek et al., 2015)	4.86E-20	(Keller-Rudek et al., 2015)	**0.32**	7.3E-02	26
peroxyacetyl nitrate	6.20E-18	(Sander et al., 2011)*5	1.00E-19	(Sander et al., 2011)	**0.11**	**0.15**	8.3
Ambient average	-	-	-	-	-		44*6

*1: estimate based on quantum chemical calculations. See details below.
*2: extrapolation from the data between 210 and 280 nm, whose logarithm manifests a good linear wavelength-dependence
*3: value at 193 nm
*4: value at 252 nm
*5: linear extrapolation from the data between 196–206 nm
*6: estimated based on i) ambient OH concentration of $1.5\text{x}10^6$ molecules cm^{-3} (Mao et al., 2009), ii) OH_{exp} of ~$2\text{x}10^{13}$ molecules cm^{-3} s in Case HHH ($1.8\text{x}10^{13}$ molecules cm^{-3} s for OFR185; $2.3\text{x}10^{13}$ molecules cm^{-3} s for OFR254-70), and iii) average ambient SOA photolysis lifetime of 3.5 d (Hodzic et al., 2015)

S1. Selection of kinetic data

This study involves photoabsorption cross-sections at 185 and 254 nm, rate constants of reactions with OH, O(^{1}D), O(^{3}P), and O_3 of a large variety of species of interest. Obviously, we are not able to include all possible reactants. Instead, we include one or two representative species for a category of species with certain functional group(s). The selection of presented species is subject to data availability. In principle, we choose species with available kinetic data to cover categories with different functional groups. However, for example, rate constants of reactions with O(^{1}D) have seldom been measured. Some categories (e.g., aromatics) are thus not covered. In case of multiple available dataset for a single cross-section/rate constant, we apply the following rules:

i) Photoabsorption cross-section data from different sources are used in the priority order of MPI-Mainz UV/VIS Spectral Atlas of Gaseous Molecules of Atmospheric Interest (Keller-Rudek et al., 2015) > JPL Chemical Kinetic Data Evaluation (Sander et al., 2011) > other sources;

ii) The latest dataset is selected in case of multiple available references in MPI-Mainz UV/VIS Spectral Atlas of Gaseous Molecules of Atmospheric Interest;

iii) Data of rate constants of thermal reactions from different sources are used in the priority order of Atkinson and Arey (2003) > JPL Chemical Kinetic Data Evaluation (Sander et al., 2011) > IUPAC Task Group on Atmospheric Chemical Kinetic Data Evaluation (Ammann et al., 2015) > other sources.

In some cases, kinetic data are also collected under certain reliable approximations, despite no available direct measurements. For example, to obtain cross-section of methylhydroperoxide at 185 nm, we make an extrapolation from the data between 210 and 280 nm, whose logarithm manifests a good linear wavelength-dependence; we use cross-section of ethyl acetate at 252 nm as that at 254 nm.

According to data in Trost et al. (1997) and Atkinson and Arey (2003), photolysis of benzaldehydes and phenols at 254 nm is significant compared to their reactions with OH. It is important to assess their photolysis at 185 nm. However, no measured cross-section data are available. Moreover, no appropriate assumptions based on available data to obtain cross-sections at 185 nm can be made. We thus make an estimation of these cross-sections based on quantum chemical calculations.

S2. Estimation of 185 nm absorption cross-sections of several aromatics

We perform time-dependent density functional theory calculations (Runge and Gross, 1984) using GAMESS program (Schmidt et al., 1993) for the molecule of interest: ground state geometry is optimized at Perdew-Burke-Ernzerhof0/6-311g(d,p) level (Perdew et al., 1996). Oscillator strengths of transitions between 160 and 300 nm are obtained by time-dependent calculations at the same level with the first 10 excited states considered. Then cross-section at 185 nm is estimated under the assumption that the ratio between cross-sections at 185 nm and absorption maximum wavelength in the longer-wavelength range, where experimental data are available in Keller-Rudek et al. (2014), is equal to that between oscillator strengths of transitions closest to 185 nm and absorption maximum wavelength, respectively. This is a very rough approximation completely neglecting vibronic structure of absorption bands. However, in this study, we only seek cross-section values on right order of magnitude, but not quantum chemical predictions quantitatively comparable to measurements, which require vibrational/vibronic wavefunctions of dissociative excited states and are far beyond this work's scope.

The main features that we find from theoretical estimates, i.e., estimated 185 nm cross-sections are around 10^{16} cm^2/molecule and 2 orders of magnitude larger than those at 254 nm, agree well with the available data for other aromatics, toluene and p-xylene (Table S1).

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