Supplementary Information for

A General Scavenging Rate Constant for the Reaction of Hydroxyl Radical with Organic Carbon in Atmospheric Waters

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Table S1. OH kinetics from laboratory studies of atmospheric hydrometeors

Ref.	Study Letter	Sample Type	P_{OH}, mol-OH L-aq^{-1} s^{-1}: Aqueous P_{OH} [a] Average	P_{OH}: Aqueous P_{OH} [a] Std Dev	P_{OH}: Mass Transport [b]	P_{OH}: $O_3 + O_2^-$ [c]	P_{OH}: Total P_{OH} [d]	P_{OH}: Total Std Dev	Aq P_{OH} / Total [e]	k'_{OH} [f], s^{-1} Average	k'_{OH} [f], s^{-1} Std Dev	[OH] [g], M Average	[OH] [g], M Std Dev
1	a	Rain	5.0E-11	2.5E-11	1.3E-13	0.0E+00	5.0E-11	2.6E-11	1.00	2.9E+04	1.1E+04	1.7E-15	1.1E-15
2	b	Rain	7.7E-11	4.6E-11	1.3E-13	0.0E+00	7.7E-11	4.6E-11	1.00	6.8E+04	5.0E+04	1.1E-15	1.1E-15
2	c	Dew	5.3E-10	2.2E-10	2.0E-10	0.0E+00	7.3E-10	3.1E-10	0.72	3.3E+05	1.0E+05	1.6E-15	8.2E-16
3	d	Cloud-remote	6.6E-10	5.7E-10	1.0E-09	2.0E-10	1.9E-09	1.6E-09	0.35				
4	d	Cloud-remote								2.6E+05	1.2E+05	7.2E-15	7.1E-15
5	e	Cloud-marine	1.4E-09	7.7E-10	1.0E-09	2.0E-10	2.6E-09	1.4E-09	0.54	2.9E+06	3.6E+06	8.8E-16	1.2E-15
	f	Cloud-urban											
5	g	Fog	1.1E-09	6.5E-10	1.6E-09	0.0E+00	2.7E-09	1.6E-09	0.40	1.2E+06	5.0E+05	2.3E-15	1.7E-15
6	h	Marine PM	1.5E-07	1.4E-07	8.3E-08	1.4E-08	2.5E-07	2.4E-07	0.60	2.6E+08	1.7E+08	5.7E-16	6.7E-16
7	i	Marine PM	1.8E-07	9.3E-08	8.3E-08	1.4E-08	2.8E-07	1.4E-07	0.65	3.8E+08	2.1E+08	4.7E-16	3.6E-16
8	j	Marine PM	4.7E-07	1.8E-07	8.3E-08	1.4E-08	5.7E-07	2.2E-07	0.83				
This work	j	Marine PM								3.5E+08	1.5E+08	1.4E-15	7.9E-16

Notes:

[a] Rate of OH photoformation in the aqueous sample measured in the laboratory. Measured values (and standard deviations) were increased by a factor of 1.5 to account for the in-drop enhancement of actinic flux[9]. For study "e", P_{OH} was calculated under mid-latitude summer conditions instead of under the winter sunlight conditions that were originally reported. For study "i", values are from conditions of fresh sea-salt particles with added nitrate and acid to simulate aged particles; values were normalized to a relative humidity of 88% (i.e., a sodium concentration of 3.1 M). There is no measured data for urban clouds.

[b] Rate of transport of gas-phase OH to the drop or particles. Rates of mass transport of OH(g) to the rain and dew drops were estimated from continuum regime mass transport assuming [OH(g)] = 2E6 mlc/cm^3. The rate for the cloud drops was taken from Herrmann et al.[10] for remote continental clouds. The rate for the fog drops was taken from Jacob et al.[11] for a low altitude winter cloud in the San Joaquin Valley of California. The rate for Marine PM was estimated from Anastasio and Newberg[6].

[c] Rate of OH formation from the aqueous reaction of O_3 and O_2^-. This rate was assumed negligible for the rain and dew drops. Values for the clouds were taken from modeled results for remote continental clouds[10]. The rate for the fog waters was taken from Jacob et al.[11] for a low altitude winter cloud in the San Joaquin Valley of California. The rate for the marine PM was taken from the marine cloud case of Monod and Carlier[12].

[d] Total rate of OH formation in the aqueous phase, calculated as the sum of the measured OH photoformation in experiments plus estimated rates for mass transport and the $O_3 + O_2^-$ reaction. The relative standard deviation for each Total P_{OH} value is assumed to be the same as for the measured Aqueous P_{OH} rate.

[e] Fraction of Total P_{OH} that was due to aqueous photoformation.

[f] Measured first-order rate constant for OH loss in the sample type. This is the total rate constant for loss, i.e., including both organic and inorganic sinks for OH.

[g] Steady-state concentration of OH expected in the aqueous phase, calculated based on Total P_{OH} and the total rate constant for loss. For case "d" (Cloud - remote) the steady- state concentration was estimated by combining P_{OH} from Faust and Allen[3] and k'_{OH} from Arakaki and Faust[4]. For case "j" (Marine PM), [OH] was determined using P_{OH} from Arakaki et al.[8] and k'_{OH} determined from this work.

Table S2. Model predictions of OH kinetics for mid-latitude cloud and fog waters [a]

			Model	Radius [b]	Study			P_{OH} (M s^{-1}) [e]			k'_{OH}	[OH]	
Ref.	Location	Day	Time	(μm)	Letter [c]	Sample Type [d]	pH	OH(g) to OH(aq)	$O_3 + O_2^-$	Total	(s^{-1})	(M)	Notes
13	NE U.S.				d	Remote	3.6-4.2					5.6E-14	f
11	35 °N	03 Jan	noon		g	Fog	3.4-3.8	1.6E-09	0	1.9E-09	1.2E+05	1.6E-14	
14	50 °N	21 Jun	noon	10	e	Marine-no TM	4.6	3.7E-09				8.6E-13	
				10	e	Marine-low TM						8.3E-13	
				10	e	Marine-high TM	4.6	3.7E-09				8.4E-13	
				5	d	Remote-no TM	3.8	1.0E-08				1.4E-13	
				5	d	Remote-low TM						2.7E-13	
				5	d	Remote-high TM	3.8	8.3E-09				5.1E-13	
				5	f	Polluted-no TM	3.3	4.3E-09				9.0E-14	
				5	f	Polluted-low TM						9.6E-14	
				5	f	Polluted-high TM	3.3	3.7E-09				1.9E-13	
15			noon		f	Urban						1.9E-12	
12		summer	5400 s	10	d	Remote	3	6.9E-09	9.0E-10	8.0E-09	2.1E+04	3.9E-13	g
				10	d	Remote	4.16	3.9E-09	4.2E-09	8.3E-09	4.2E+04	2.0E-13	
				10	d	Remote	5.2	3.0E-09	1.4E-08	1.7E-08	7.7E+04	2.2E-13	
				10	d	Remote	6	2.5E-09	2.8E-08	3.1E-08	2.0E+04	1.5E-12	
16	48 °N		midday	5	d	Remote-no TM	4.6	1.1E-09	6.7E-09	8.4E-09	1.7E+05	5.0E-14	h
					d	Remote-with TM	4.6	9.2E-10	5.2E-11	4.3E-09	1.7E+05	2.6E-14	
17	51 °N		36 hr	1	e	Marine	3.8	5.6E-09	2.1E-10	1.3E-08	6.5E+03	2.0E-12	i
				1	d	Remote	3.4	6.0E-09	0.0E+00	1.7E-08	1.0E+04	1.7E-12	
				1	f	Urban	2.7	9.4E-09	0.0E+00	2.4E-08	1.7E+04	1.4E-12	
				5	f	Urban						4.5E-13	
				10	f	Urban						2.2E-13	

18	45 °N	21 Jun	Noon		d	Remote	5					2.4E-12	j
19					e	Marine						1.8E-13	
20			6 hr	polydisp.	f	Polluted						1.5E-13	k
				polydisp.	d	Remote	3.5-4.5					3.8E-13	
21	51 °N	24 Jun	noon	10	d	Remote	3.4	3.5E-09	1.5E-10	9.5E-09	1.8E+04	5.3E-13	
				10	f	Urban	2.6	1.4E-09	4.0E-11	1.1E-08	1.0E+04	1.1E-12	
				10	e	Marine	3.5	2.8E-09	5.8E-10	5.5E-09	4.2E+03	1.3E-12	
10	51 °N	23 Jun	noon	polydisp.	d	Remote	3.9	1.0E-09	2.0E-10	4.6E-09	4.2E+04	1.1E-13	l
				polydisp.	f	Polluted						1.1E-14	
				polydisp.	e	Marine						7.3E-13	
22	50 °N	summer	noon	12	e	Marine cloud	~ 4.5					3.9E-13	
					h,i,j	Marine PM	~ 3.0					4.0E-16	
23	45 °N	19 Jun			d	Remote	5.0					5.0E-14	m
					f	Urban	3.3					1.0E-14	
						Remote PM	2.3					3.6E-12	
						Urban PM	1.4					8.0E-13	

Notes:

[a] Modeling studies were chosen to approximately match the conditions of the measured samples: summer, mid-latitude cloud drops and winter, mid-latitude (California's Central Valley) for fog drops. None of the models include any potential enhancement of photolysis rates at the drop and particle surfaces; since this potential enhancement is also not operative in our measurements (because of the low surface areas in the bulk solutions), this exclusion does not introduce a bias in the comparison of modeled and measured results.

b Radius of aqueous drops in a given scenario or study. "polydisp." = polydispersed drops.

[c] Corresponds to Study Letter in Table S1 and the bar markers in Figure 1 of the main text.

[d] Sample type is cloud (remote continental, marine, or polluted/urban) unless noted otherwise as Fog or PM (particulate matter). "TM" = aqueous reactions of transition metals (typically Fe and Cu).

[e] Rate of OH formation in aqueous phase, including contributions from mass transport of gas-phase OH ("OH(g) to OH(aq)" column) and the aqueous reaction of ozone with superoxide ("$O_3 + O_2^-$" column).

[f] [OH] estimated from reported CH_3OH decay.

[g] P_{OH} from Fig 1e; [OH] from Fig 1b; k'_{OH} calculated

[h] P_{OH} and [OH] from text; k'_{OH} calculated

[i] Results are for continuous cloud case. k'_{OH} calculated from values of [OH] and P_{OH} in figures.

[j] [OH] calculated based on data in tables 7 and 9.

[k] Model does not include aqueous photolysis reactions.

[l] k'_{OH} for Remote case calculated based on [OH] from Fig. 1a. and P_{OH} from Fig. 2. [OH] for polluted and marine cases from A. Tilgner and H. Herrmann, personal communication.

[m] [OH] from Table A6 of supplemental material.

Table S3. Contribution of OH scavenging by dissolved ions and k'_{OH}/[DOC] values for the PM samples collected at Cape Hedo, Okinawa, Japan.

Sample Name[a]	OH Scavenging ions[b]				at [Na] = 3.1M	at [Na] = 3.1M	Ion corrected
	NO_3^-	NO_2^-	SO_4^{2-}	Br^- [c]	DOC	Ion corrected k'_{OH}	k'_{OH}/[DOC])
	(%)	(%)	(%)	(%)	(M)	(s^{-1})	(L mol-C^{-1} s^{-1})
CH050815-22	0.01	1.74	0.12	0.04	3.39	3.30E+09	9.74E+08
CH050822-29	0.00	5.37	0.28	0.06	1.88	8.74E+08	4.65E+08
CH050829-05	0.01	3.27	0.29	0.82	0.22	2.70E+08	1.23E+09
CH050905-12	0.03	7.59	0.22	3.91	0.30	1.46E+08	4.82E+08
CH050912-19	0.03	5.71	0.19	1.45	1.33	6.19E+08	4.64E+08
CH050919-26	0.00	4.42	0.61	0.10	0.70	6.20E+08	8.80E+08
CH050926-03	0.06	4.88	0.39	2.04	0.39	1.44E+08	3.66E+08
CH051003-10	0.02	4.01	0.19	0.83	0.52	4.23E+08	8.14E+08
CH051010-17	0.04	4.79	0.31	1.43	0.28	1.37E+08	4.83E+08
CH051017-24	0.07	5.84	0.51	1.49	0.68	1.03E+08	1.53E+08
CH051024-31	0.04	5.57	0.45	1.66	1.47	2.41E+08	1.64E+08
CH051031-07	0.07	9.62	0.72	3.13	0.89	1.30E+08	1.46E+08
CH051107-14	0.01	3.52	0.46	0.28	1.89	4.42E+08	2.34E+08
CH051121-28	0.04	5.35	0.71	0.68	2.08	2.97E+08	1.43E+08
CH051128-05	0.03	4.82	0.62	2.00	1.07	1.85E+08	1.73E+08
CH051205-12	0.02	6.04	0.44	1.78	0.45	1.58E+08	3.50E+08
CH051212-19	0.03	4.31	0.37	1.07	0.94	2.94E+08	3.15E+08
CH051219-26	0.03	3.55	0.28	1.00	0.71	2.47E+08	3.47E+08
CH051226-02	0.03	9.73	0.55	3.44	0.81	1.44E+08	1.78E+08
CH060102-09	0.01	5.04	0.43	1.39	0.66	2.14E+08	3.25E+08
CH060109-16	0.03	5.26	0.65	0.42	2.04	3.05E+08	1.50E+08
CH060116-23	0.04	9.07	0.62	2.85	0.98	1.51E+08	1.54E+08
CH060123-30	0.05	11.0	0.45	53.3	1.14	3.41E+07	2.99E+07
CH060130-06 [d]	0.09	11.7	1.94	118	0.68	-	-
CH060206-13	0.04	4.58	0.68	13.8	1.17	1.96E+08	1.68E+08
CH060213-20	0.06	9.72	0.83	42.1	0.62	6.26E+07	1.01E+08
CH060220-27	0.07	5.04	0.62	15.2	1.17	1.66E+08	1.41E+08
CH060227-06	0.03	4.07	0.55	5.62	1.19	2.55E+08	2.13E+08
CH060306-13	0.05	6.14	0.75	15.1	0.63	1.51E+08	2.38E+08
CH060313-20	0.18	6.72	1.41	28.0	1.64	1.04E+08	6.32E+07
CH060320-27	0.05	5.12	0.52	15.2	0.77	1.87E+08	2.43E+08
CH060327-03	0.07	5.91	0.50	1.07	1.65	2.74E+08	1.67E+08
CH060403-10	0.04	2.29	0.33	3.73	1.07	5.41E+08	5.07E+08
CH060410-17	0.05	3.30	0.39	4.62	0.87	2.76E+08	3.18E+08
CH060417-24	0.03	3.39	0.36	0.67	1.45	3.85E+08	2.66E+08
CH060424-01	0.05	7.67	0.43	7.95	2.42	4.47E+08	1.85E+08
CH060501-08	0.05	7.71	0.86	1.20	1.49	1.83E+08	1.23E+08
CH060508-15	0.01	1.36	0.14	0.17	2.86	1.50E+09	5.23E+08
CH060515-22	0.02	1.49	0.21	0.11	3.17	1.16E+09	3.66E+08
CH060522-29	0.00	1.17	0.15	0.02	0.51	2.99E+08	5.82E+08
CH060529-05	0.02	8.64	0.53	2.59	0.80	1.78E+08	2.23E+08
CH060605-12	0.03	8.81	0.52	2.63	1.21	1.80E+08	1.49E+08
CH060612-19	0.02	6.04	0.12	1.02	1.84	5.90E+08	3.20E+08
CH060619-26	0.03	7.79	0.21	0.89	1.91	5.42E+08	2.84E+08
CH060626-03	0.03	15.1	0.25	2.32	1.28	2.43E+08	1.89E+08
CH060710-17	0.02	5.74	0.29	2.10	0.39	1.35E+08	3.48E+08
CH060717-24	0.05	15.7	0.34	4.90	0.92	1.58E+08	1.71E+08
CH060724-31	0.02	7.97	0.19	1.84	0.84	3.48E+08	4.16E+08
CH060731-07	0.02	12.0	0.74	4.03	0.54	1.27E+08	2.35E+08
CH060807-14	0.05	11.4	0.50	7.31	0.50	1.01E+08	2.01E+08
CH060814-21	0.01	7.07	1.23	0.07	0.65	2.44E+08	3.75E+08
CH060821-28	0.04	11.0	0.27	3.90	0.69	1.74E+08	2.53E+08
CH060828-05	0.00	13.2	2.10	0.14	1.35	1.54E+08	1.14E+08
CH060905-12	0.06	9.32	0.89	2.44	1.28	1.40E+08	1.10E+08
CH060912-19	0.05	7.55	0.40	2.34	0.54	9.46E+07	1.75E+08
CH060919-26	0.03	4.00	0.59	0.87	0.99	2.99E+08	3.04E+08
CH060926-03	0.11	9.04	1.19	3.30	0.68	1.06E+08	1.56E+08
CH061003-10	0.06	7.12	0.69	2.05	0.40	7.88E+07	1.99E+08
CH061010-17	0.07	4.79	1.17	1.56	0.90	1.45E+08	1.62E+08
CH061017-24	0.03	5.26	0.56	1.63	0.59	1.54E+08	2.61E+08
CH061024-31	0.12	7.60	0.88	2.57	0.66	9.89E+07	1.51E+08
Mean	0.04	6.61	0.56	4.84	1.10	3.32E+08	3.00E+08
Standard deviation	0.03	3.22	0.39	9.43	0.69	4.66E+08	2.23E+08

Notes:

[a] The sample name indicates the date of sampling; e.g., sample CH050815-22 was collected between in 2005 from August 15 to 22.

[b] OH scavenging represents the percent of the OH sink that was due to each of four inorganic ions. For each ion in a given sample this was calculated based on the ion concentration times the bimolecular rate constant for the ion with OH, divided by the OH scavenging rate constant measured in the sample. Rate constants for OH with the four inorganic ions were from Arakaki and Faust[4] and Ross et al[24].

[c] The first-order rate constant for OH scavenging by Br^- was calculated based on the equations in Anastasio and Newberg[6].

[d] CH060130-06 contained an unusually high concentration of bromide ion, which accounted for all OH scavenging. Thus this sample was omitted from the data analysis.

Table S4a. Summary of calculations of $k_{C,OH}$ for organics reported in the literature

Reference	% of DOC identified [a]	$k_{C,OH}$ for identified species (L mol-C^{-1} s^{-1}) [b]	Calculated $k_{C,OH}$ / Avg atmos. water value [c]	Sample Type
25	15.1	8.7E+08	2.29	Fog water, Davis, CA, USA
26	57	6.2E+08	1.63	Fog water, Central Valley of CA, USA
27,28	58.4	7.5E+08	1.87	Fog water, Baton Rouge, LA, USA
27,28	63	1.3E+09	3.41	Fog water, Houston, TX, USA
29	14	3.9E+08	1.03	Particulate matter, Asia

Mean	7.8E+08	2.04
Std. dev.	3.4E+08	0.89

Atmospheric Mean Value
3.8E+08 (L mol-C^{-1} s^{-1})

Notes:
Calculations for each sample on are subsequent pages.
[a] Percent of total DOC that could be accounted for by measured individual organic compounds.
[b] Calculated value of $k_{C,OH}$ based only on measured individual organic compounds.
[c] Ratio of the calculated value of $k_{C,OH}$ to the average value determined in atmospheric waters (i.e., 3.8E8 L mol-C^{-1} s^{-1}).

Table S4b. Calculation of $k_{C,OH}$ for California fog waters from Herckes et al.[25]

Species	Molecular formula	Carbon #, n(C)	% of DOC [a]	% of ID'd DOC [b]	Rate Constant, $k_{S,OH}$ [c] (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) [d] (L mol-C^{-1} s^{-1})	OH Scavenger Contribution [e]
Acetate	CH_3COO^-	2	8	52.9%	8.50E+07	2.25E+07	2.6%
Formate	$HCOO^-$	1	2.6	17.2%	3.50E+09	6.02E+08	69.3%
Formaldehyde	CH_4O_2	1	4.4	29.1%	8.10E+08	2.36E+08	27.1%
n-Alkanes	$C_{23}H_{48}$	23	0.1	0.7%	2.83E+10	8.14E+06	0.9%
Naphtalene	$C_{10}H_8$	16	0.02	0.1%	9.60E+09	7.94E+05	0.1%
		Identified	15.1	100.0%	Sum:	**8.69E+08**	100.0%

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **2.3**

Notes:

[a] Percent of *measured* DOC that was contributed by a given compound.

[b] Percent of *identified* DOC that was contributed by a given compound.

[c] Bimolecular rate constants for OH with each organic compound. All rate constants are from Ross et al.[24].

[d] Value of $k_{C,OH}$ in the sample contributed by a given compound, calculated as % of identified DOC × C-based rate constant for compound. The sum of these contributions is the value of $k_{C,OH}$ for all of the identified organic species in the sample.

[e] Percent of identified OH scavenging (i.e., from identified organics) that was contributed by a given compound.

Table S4c. Calculation of $k_{C,OH}$ for California fog waters from Collett et al.[26]

Species	Molecular formula	Carbon #, n(C)	% of of DOC	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Rate constant reference
Acetate	CH_3COO^-	2	26	46%	8.50E+07	1.94E+07	3.1%	24
Formate	$HCOO^-$	1	7	12%	3.50E+09	4.30E+08	69.6%	24
Propionate	$C_2H_5COO^-$	3	2	4%	5.00E+08	5.85E+06	0.9%	24
Oxalate	$C_2O_4^{2-}$	2	3	5%	7.70E+06	2.03E+05	0.0%	24
Formaldehyde	CH_2O	1	4	7%	8.10E+08	5.68E+07	9.2%	24
Glyoxal	$C_2H_2O_2$	2	3	5%	6.60E+07	1.74E+06	0.3%	24
Methylglyoxal	$C_3H_4O_2$	3	3	5%	1.10E+09	1.93E+07	3.1%	30
Pyruvate	$C_3H_4O_3$	3	1	2%	7.00E+08	4.09E+06	0.7%	30
Glutarate	$C_5H_8O_3$	5	1	2%	7.40E+08	2.60E+06	0.4%	31
Succinate	$C_4O_6H_4$	4	1	2%	5.00E+08	2.19E+06	0.4%	30
Malonate	$C_3H_4O_4$	3	1	2%	6.00E+07	3.51E+05	0.1%	30
Lactate	$C_3H_6O_3$	3	1	2%	7.77E+08	4.54E+06	0.7%	32
Acetaldehyde	CH_3CHO	2	2	4%	3.60E+09	6.32E+07	10.2%	24
Acetone/acrolein	C_3H_6O	3	1	2%	1.10E+08	6.43E+05	0.1%	24
Levoglucosan	$C_6H_{10}O_5$	6	1	2%	2.40E+09	7.02E+06	1.1%	24
		Identified	57	100%	Sum:	**6.18E+08**	100.0%	

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **1.6**

Notes:
See Table S4b for a description of columns.

Table S4d. Calculation of $k_{C,OH}$ for Baton Rouge, Louisiana fog waters from Raja et al.[27,28]

Species	Molecular formula	Carbon #, n(C)	Conc. (mg-C L^{-1})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Lactate	$C_3H_6O_3$	3	1.31	31.6%	4.30E+08	4.52E+07	6.1%	
Acetate	CH_3COO^-	2	0.16	3.9%	8.50E+07	1.64E+06	0.2%	
Formate	$HCOO^-$	1	0.16	3.9%	3.50E+09	1.35E+08	18.0%	
Pyruvate	$C_3H_3O_3^-$	3	0.07	1.7%	3.10E+07	1.74E+05	0.0%	
Pinonate	$C_{10}H_{16}O_3$	10	0.16	3.9%	8.00E+09	3.08E+07	4.1%	b
Succinate	$C_4H_6O_4$	4	0	0.0%	3.10E+08	0.00E+00	0.0%	
Pimelate	$C_7H_{12}O_4$	7	0.01	0.2%	3.50E+09	1.20E+06	0.2%	
Malonate	$C_3H_4O_4$	3	0	0.0%	2.00E+07	0.00E+00	0.0%	
Maleate	$C_4H_4O_4$	4	0.09	2.2%	6.00E+09	3.25E+07	4.4%	
Oxalate	$HC_2O_4^-$	2	0.08	1.9%	4.70E+07	4.53E+05	0.1%	
Octadecane	$C_{18}H_{38}$	18	0.01	0.2%	2.19E+10	2.93E+06	0.4%	c
Docosane	$C_{22}H_{46}$	22	0.003	0.1%	2.70E+10	8.87E+05	0.1%	c
Tricosane	$C_{23}H_{48}$	23	0.002	0.0%	2.83E+10	5.93E+05	0.1%	c
Tetracosane	$C_{24}H_{50}$	24	0.006	0.1%	2.96E+10	1.78E+06	0.2%	c
Pentacosane	$C_{25}H_{52}$	25	0.007	0.2%	3.09E+10	2.08E+06	0.3%	c
Hexacosane	$C_{26}H_{54}$	26	0.002	0.0%	3.21E+10	5.95E+05	0.1%	c
Octacosane	$C_{28}H_{58}$	28	0.004	0.1%	3.47E+10	1.19E+06	0.2%	c
Nonacosane	$C_{29}H_{60}$	29	0.01	0.2%	3.60E+10	2.99E+06	0.4%	c
Phenanthrorene	$C_{12}N_2H_8$	12	0.0001	0.0%	8.30E+09	1.67E+04	0.0%	
9,10-anthracenedione	$C_{14}H_8O_2$	14	0.00015	0.0%	1.20E+10	3.10E+04	0.0%	b
1,8-Naphthaliac anhydride	$C_{12}H_6O_3$	12	0.0002	0.0%	8.50E+09	3.41E+04	0.0%	b
1,2,3-trimethyl benzene	C_9H_{12}	9	0.0004	0.0%	7.00E+09	7.50E+04	0.0%	

1,2,4-trimethyl benzene	C_9H_{12}	9	0.018	0.4%	1.00E+10	4.82E+06	0.6%	b
1,2,3,4-tetramethyl benzene	$C_{10}H_{14}$	10	0.0001	0.0%	7.20E+09	1.73E+04	0.0%	
Formaldehyde	CH_2O_2	1	0.40	9.6%	8.10E+08	7.81E+07	10.4%	
Acetaldehyde	C_2H_4O	2	0.08	1.9%	3.60E+09	3.47E+07	4.6%	
Acrolein	C_3H_4O	3	0.09	2.2%	7.00E+09	5.06E+07	6.8%	
Isovaleraldehyde	$C_5H_{10}O$	5	0.03	0.6%	4.10E+09	4.94E+06	0.7%	b
2-Chlorocyclo-hexanol	$C_6H_{11}ClO$	6	0.50	12.0%	5.00E+09	1.00E+08	13.4%	b
13-Docosenamide (z)	$C_{22}H_{43}NO$	8	0.10	2.4%	7.90E+09	2.38E+07	3.2%	b
Atrazine	$C_8H_{14}ClN_5$	8	0.00	0.1%	2.60E+09	1.96E+05	0.0%	
Diethyl Toluamide	$C_{12}H_{17}NO$	12	0.03	0.7%	8.50E+09	5.12E+06	0.7%	b
Octadecanamide	$C_{18}H_{37}NO$	18	0.08	1.9%	7.40E+09	7.92E+06	1.1%	b
4-Nitrophenol	$C_6H_5NO_3$	6	0.04	1.0%	3.80E+09	6.10E+06	0.8%	
1,2-Benzene dicarboxylic acid	$C_8H_6O_4$	8	0.70	16.9%	8.10E+09	1.71E+08	22.8%	b
			4.15	100.0%	**Sum**	**7.48E+08**	100.0%	

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **2.0**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].
[c] Calculated rate constant from a linear extrapolation of alkane values: $k_{S,OH}$ (L mol-compound^{-1} s^{-1}) = 1.28E9 × n(C) - 1.15e9

Table S4e. Calculation of $k_{C,OH}$ for Houston, Texas fog waters from Raja et al.[27,28]

Species	Molecular formula	Carbon #, n(C)	Conc. (mg-C L^{-1})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L $mol\text{-}cmpd^{-1}$ s^{-1})	% ID'd × k/n(C) (L $mol\text{-}C^{-1}$ s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Lactate	$C_3H_6O_3$	3	0.19	3.7%	4.30E+08	5.24E+06	0.4%	
Acetate	CH_3COO	2	0.64	12.3%	8.50E+07	5.24E+06	0.4%	
Formate	$HCOO^-$	1	1.43	27.5%	3.50E+09	9.64E+08	74.5%	
Pyruvate	$C_3H_3O_3^-$	3	0.03	0.6%	3.10E+07	5.97E+04	0.0%	
Succinate	$C_4H_6O_4$	4	0.88	16.9%	3.10E+08	1.31E+07	1.0%	
Pimelate	$C_7H_{12}O_4$	7	0.72	13.9%	3.50E+09	6.93E+07	5.4%	
Malonate	$C_3H_4O_4$	3	0.2	3.9%	2.00E+07	2.57E+05	0.0%	
Maleate	$C_4H_4O_4$	4	0.78	15.0%	6.00E+09	2.25E+08	17.4%	
Oxalate	$HC_2O_4^-$	2	0.24	4.6%	4.70E+07	1.09E+06	0.1%	
1,2-acenaphthylenedione	$C_{12}H_6O_2$	12	0.0117	0.2%	8.50E+09	1.60E+06	0.1%	b
9H-fluoren-9-one	$C_{13}H_8O$	13	0.0126	0.2%	9.00E+09	1.68E+06	0.1%	b
9,10-Anthracenedione	$C_{14}H_8O_2$	14	0.004	0.1%	1.20E+10	6.60E+05	0.1%	b
1,8-Naphthalic anhydride	$C_{12}H_6O_3$	12	0.013	0.3%	8.50E+09	1.77E+06	0.1%	b
Benzene, 1,4-dichloro	$C_6H_4Cl_2$	6	0.00025	0.0%	5.20E+09	4.17E+04	0.0%	
Nopinone	$C_9H_{14}O$	9	0.0019	0.0%	1.00E+10	4.06E+05	0.0%	b
Diethyl Phthalate	$C_{12}H_{14}O_4$	12	0.012	0.2%	8.50E+09	1.64E+06	0.1%	b
Dibutyl Phthalate	$C_{16}H_{22}O_4$	16	0.008	0.2%	1.00E+10	9.63E+05	0.1%	b
Triphenyl Phosphate	$C_{18}H_{15}O_4P$	18	0.007	0.1%	7.40E+09	5.54E+05	0.0%	b
2-cyclohexen-1-one	C_6H_8O	6	0.0003	0.0%	5.00E+09	4.81E+04	0.0%	b
1H-Phenalen-1-one	$C_{13}H_8O$	13	0.013	0.3%	9.00E+09	1.73E+06	0.1%	b
			5.194	100.0%	**Sum**	**1.29E+09**	100.0%	

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value:	**3.4**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

Table S4f. Summary of $k_{C,OH}$ data for Asian aerosol particles from Mader et al.[29]

Sample	Calculated $k_{C,,OH}$ (L mol-C^{-1} s^{-1})	Ratio to Atm. Value	% of identified OH scavenging due to formate
A	3.77E+08	0.99	53.2%
B	3.40E+08	0.89	71.4%
C	5.54E+08	1.46	76.4%
D	5.03E+08	1.32	70.1%
E	2.26E+08	0.59	49.4%
F	3.54E+08	0.93	62.7%
Average	3.92E+08	1.03	63.9%

Note:

Data for the individual samples (A – F) are on the subsequent pages.

Table S4g. Calculation of $k_{C,OH}$ for Asian aerosol particles from Mader et al.[29]

Sample A

Species	Molecular formula	Carbon #, n(C)	Conc. (pmol/m^3)	M.W. (g/mol)	Conc. (ng m^{-3})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Formate	$HCOO^-$	1			23	5.7%	3.50E+09	2.00E+08	53.2%	
Acetate	CH_3COO^-	2			23	5.7%	8.50E+07	2.43E+06	0.6%	
Lactate	$C_3H_6O_3$	3			97	24.1%	7.77E+08	6.25E+07	16.6%	
MSA	CH_4O_3S	1			11	2.7%	5.40E+07	1.48E+06	0.4%	
Oxalate	$C_2O_4^{2-}$	2			122	30.4%	4.70E+07	7.14E+06	1.9%	
Malonate	$C_3H_4O_4$	3			20	5.0%	2.00E+07	3.32E+05	0.1%	
Maleate	$C_4H_4O_4$	4			9	2.2%	6.00E+09	3.36E+07	8.9%	
Succinate	$C_4H_6O_4$	4			0	0.0%	3.10E+08	0.00E+00	0.0%	
Glutarate	$C_5H_8O_3$	5			8	2.0%	7.40E+08	2.95E+06	0.8%	
Glycine	$C_2H_5NO_2$	2	274.4	75.07	21	5.1%	1.70E+07	4.36E+05	0.1%	
Alanine	$C_3H_7NO_2$	3	61.1	89.09	5	1.4%	1.91E+08	8.61E+05	0.2%	
Proline	$C_5H_9NO_2$	5	40.3	115.13	5	1.2%	4.80E+08	1.11E+06	0.3%	
Cysteine	$C_6H_{12}N_2O_4S_2$	6	2.1	240.3	1	0.1%	2.10E+09	4.40E+05	0.1%	
Threonine	$C_4H_9NO_3$	4	39.1	119.12	5	1.2%	5.10E+08	1.48E+06	0.4%	
2-Alanine	$C_3H_7NO_2$	3	28.3	89.09	3	0.6%	1.91E+08	3.99E+05	0.1%	
Glutamic acid	$C_5H_9NO_4$	5	28.6	147.13	4	1.0%	1.60E+08	3.35E+05	0.1%	
Aspartic acid	$C_4H_7NO_4$	4	16.6	133.1	2	0.5%	3.90E+09	5.36E+06	1.4%	b
Valine	$C_5H_{11}NO_2$	5	17.7	117.15	2	0.5%	7.55E+08	7.79E+05	0.2%	
Serine	$C_3H_7NO_3$	3	12.7	105.09	1	0.3%	2.50E+08	2.77E+05	0.1%	
2-Aminobutyric acid	$C_4H_9NO_2$	4	9.4	103.12	1	0.2%	5.30E+08	3.20E+05	0.1%	
Lysine	$C_6H_{14}N_2O_2$	6	11.3	146.19	2	0.4%	3.50E+08	2.40E+05	0.1%	
Leucine	$C_6H_{13}NO_2$	6	3.6	131.17	0	0.1%	1.50E+09	2.94E+05	0.1%	
Galactosamine	$C_6H_{13}NO_5$	6	15.6	179.17	3	0.7%	5.00E+09	5.80E+06	1.5%	b

Tyrosine	$C_9H_{11}NO_3$	9	6.7	181.19	1	0.3%	1.30E+10	4.36E+06	1.2%	
Ornithine	$C_5H_{12}N_2O_2$	5	6.3	132.16	1	0.2%	1.08E+08	4.46E+04	0.0%	
Isoleucine	$C_6H_{13}NO_2$	6	4.4	131.17	1	0.1%	1.80E+09	4.31E+05	0.1%	
Phenylamine	$C_6H_5NH_2$	6	0.9	93.13	0	0.0%	1.29E+10	4.49E+05	0.1%	
Histidine	$C_6H_9N_3O_2$	6	0	155.15	0	0.0%	4.80E+09	0.00E+00	0.0%	
Methionine	$C_5H_{11}NO_2S$	5	0	149.21	0	0.0%	4.10E+09	0.00E+00	0.0%	b
Arginine	$C_6H_{14}N_4O_2$	6	0	174.2	0	0.0%	5.00E+09	0.00E+00	0.0%	b
Glycolic	$C_2H_4O_3$	2			5.2	1.3%	7.00E+08	4.53E+06	1.2%	
Glycerol	$C_3H_8O_3$	3			6.8	1.7%	1.90E+09	1.07E+07	2.8%	
Phthalic	$C_8H_4O_4$	8			8.8	2.2%	5.90E+09	1.62E+07	4.3%	
Levoglucosan	$C_6H_{10}O_5$	6			11.2	2.8%	2.40E+09	1.12E+07	3.0%	

Identified: 401.8 100.0% Sum: **3.77E+08** 100.0%

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **0.99**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

Table S4h. Calculation of $k_{C,OH}$ for Asian aerosol particles from Mader et al.[29]

Sample B

Species	Molecular formula	Carbon #, n(C)	Conc. (pmol/m^3)	M.W. (g/mol)	Conc. (ng m^{-3})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Formate	$HCOO^-$	1			29	6.9%	3.50E+09	2.43E+08	71.4%	
Acetate	CH_3COO^-	2			51	12.2%	8.50E+07	5.18E+06	1.5%	
Lactate	$C_3H_6O_3$	3			2	0.5%	7.77E+08	1.24E+06	0.4%	
MSA	CH_4O_3S	1			29	6.9%	5.40E+07	3.74E+06	1.1%	
Oxalate	$C_2O_4^{2-}$	2			140	33.5%	4.70E+07	7.86E+06	2.3%	
Malonate	$C_3H_4O_4$	3			26	6.2%	2.00E+07	4.14E+05	0.1%	
Maleate	$C_4H_4O_4$	4			0	0.0%	6.00E+09	0.00E+00	0.0%	
Succinate	$C_4H_6O_4$	4			32	7.6%	3.10E+08	5.93E+06	1.7%	
Glutarate	$C_5H_8O_3$	5			21	5.0%	7.40E+08	7.43E+06	2.2%	
Glycine	$C_2H_5NO_2$	2	223.5	75.07	17	4.0%	1.70E+07	3.41E+05	0.1%	
Alanine	$C_3H_7NO_2$	3	60	89.09	5	1.3%	1.91E+08	8.12E+05	0.2%	
Proline	$C_5H_9NO_2$	5	66.1	115.13	8	1.8%	4.80E+08	1.75E+06	0.5%	
Cysteine	$C_6H_{12}N_2O_4S_2$	6	26.1	240.3	6	1.5%	2.10E+09	5.25E+06	1.5%	
Threonine	$C_4H_9NO_3$	4	0	119.12	0	0.0%	5.10E+08	0.00E+00	0.0%	
2-Alanine	$C_3H_7NO_2$	3	41.1	89.09	4	0.9%	1.91E+08	5.56E+05	0.2%	
Glutamic acid	$C_5H_9NO_4$	5	0.2	147.13	0	0.0%	1.60E+08	2.25E+03	0.0%	
Aspartic acid	$C_4H_7NO_4$	4	0	133.1	0	0.0%	3.90E+09	0.00E+00	0.0%	b
Valine	$C_5H_{11}NO_2$	5	14.1	117.15	2	0.4%	7.55E+08	5.96E+05	0.2%	
Serine	$C_3H_7NO_3$	3	0	105.09	0	0.0%	2.50E+08	0.00E+00	0.0%	
2-Amino-butyric acid	$C_4H_9NO_2$	4	12.1	103.12	1	0.3%	5.30E+08	3.95E+05	0.1%	
Lysine	$C_6H_{14}N_2O_2$	6	6.4	146.19	1	0.2%	3.50E+08	1.30E+05	0.0%	
Leucine	$C_6H_{13}NO_2$	6	22.9	131.17	3	0.7%	1.50E+09	1.79E+06	0.5%	
Galactosamine	$C_6H_{13}NO_5$	6	7.1	179.171	1	0.3%	5.00E+09	2.53E+06	0.7%	b

Tyrosine	$C_9H_{11}NO_3$	9	12.9	181.19	2	0.6%	1.30E+10	8.07E+06	2.4%	
Ornithine	$C_5H_{12}N_2O_2$	5	10.8	132.16	1	0.3%	1.08E+08	7.33E+04	0.0%	
Isoleucine	$C_6H_{13}NO_2$	6	5.3	131.17	1	0.2%	1.80E+09	4.98E+05	0.1%	
Phenylamine	$C_6H_5NH_2$	6	2	93.13	0	0.0%	1.29E+10	9.57E+05	0.3%	
Histidine	$C_6H_9N_3O_2$	6	0	155.15	0	0.0%	4.80E+09	0.00E+00	0.0%	
Methionine	$C_5H_{11}NO_2S$	5	0	149.21	0	0.0%	4.10E+09	0.00E+00	0.0%	b
Arginine	$C_6H_{14}N_4O_2$	6	0	174.2	0	0.0%	5.00E+09	0.00E+00	0.0%	b
Glycolic	$C_2H_4O_3$	2			11	2.6%	7.00E+08	9.20E+06	2.7%	
Glycerol	$C_3H_8O_3$	3			6.8	1.6%	1.90E+09	1.03E+07	3.0%	
Phthalic	$C_8H_4O_4$	8			5.6	1.3%	5.90E+09	9.87E+06	2.9%	
Levoglucosan	$C_6H_{10}O_5$	6			12.6	3.0%	2.40E+09	1.20E+07	3.5%	
				Identified:	418.5	100.0%	Sum:	**3.40E+08**	100.0%	

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **0.89**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

Table S4i. Calculation of $k_{C,OH}$ for Asian aerosol particles from Mader et al.[29]

Sample C

Species	Molecular formula	Carbon #, n(C)	Conc. (pmol/m^3)	M.W. (g/mol)	Conc. (ng m^{-3})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Formate	$HCOO^-$	1			219	12.1%	3.50E+09	4.24E+08	76.4%	
Acetate	CH_3COO^-	2			131	7.2%	8.50E+07	3.08E+06	0.6%	
Lactate	$C_3H_6O_3$	3			44	2.4%	7.77E+08	6.30E+06	1.1%	
MSA	CH_4O_3S	1			40	2.2%	5.40E+07	1.19E+06	0.2%	
Oxalate	$C_2O_4^{2-}$	2			634	35.0%	4.70E+07	8.23E+06	1.5%	
Malonate	$C_3H_4O_4$	3			111	6.1%	2.00E+07	4.09E+05	0.1%	
Maleate	$C_4H_4O_4$	4			22	1.2%	6.00E+09	1.82E+07	3.3%	
Succinate	$C_4H_6O_4$	4			65	3.6%	3.10E+08	2.78E+06	0.5%	
Glutarate	$C_5H_8O_3$	5			69	3.8%	7.40E+08	5.64E+06	1.0%	
Glycine	$C_2H_5NO_2$	2	1567.6	75.07	118	6.5%	1.70E+07	5.53E+05	0.1%	
Alanine	$C_3H_7NO_2$	3	198.4	89.09	18	1.0%	1.91E+08	6.21E+05	0.1%	
Proline	$C_5H_9NO_2$	5	105.9	115.13	12	0.7%	4.80E+08	6.47E+05	0.1%	
Cystine	$C_6H_{12}N_2O_4S_2$	6	164.2	240.3	39	2.2%	2.10E+09	7.63E+06	1.4%	
Threonine	$C_4H_9NO_3$	4	134.3	119.12	16	0.9%	5.10E+08	1.13E+06	0.2%	
2-Alanine	$C_3H_7NO_2$	3	117.9	89.09	11	0.6%	1.91E+08	3.69E+05	0.1%	
Glutamic acid	$C_5H_9NO_4$	5	94.4	147.13	14	0.8%	1.60E+08	2.46E+05	0.0%	
Aspartic acid	$C_4H_7NO_4$	4	73.9	133.1	10	0.5%	3.90E+09	5.30E+06	1.0%	b
Valine	$C_5H_{11}NO_2$	5	56.3	117.15	7	0.4%	7.55E+08	5.50E+05	0.1%	
Serine	$C_3H_7NO_3$	3	48.9	105.09	5	0.3%	2.50E+08	2.37E+05	0.0%	
2-Aminobutyric acid	$C_4H_9NO_2$	4	43.2	103.12	4	0.2%	5.30E+08	3.26E+05	0.1%	
Lysine	$C_6H_{14}N_2O_2$	6	19.9	146.19	3	0.2%	3.50E+08	9.38E+04	0.0%	
Leucine	$C_6H_{13}NO_2$	6	4	131.17	1	0.0%	1.50E+09	7.25E+04	0.0%	
Galactosamine	$C_6H_{13}NO_5$	6	96.5	179.171	17	1.0%	5.00E+09	7.96E+06	1.4%	b

Tyrosine	$C_9H_{11}NO_3$	9	56	181.19	10	0.6%	1.30E+10	8.10E+06	1.5%	
Ornithine	$C_5H_{12}N_2O_2$	5	19.8	132.16	3	0.1%	1.08E+08	3.11E+04	0.0%	
Isoleucine	$C_6H_{13}NO_2$	6	20.4	131.17	3	0.1%	1.80E+09	4.44E+05	0.1%	
Phenylamine	$C_6H_5NH_2$	6	13.7	93.13	1	0.1%	1.29E+10	1.52E+06	0.3%	
Histidine	$C_6H_9N_3O_2$	6	15.6	155.15	2	0.1%	4.80E+09	1.07E+06	0.2%	
Methionine	$C_5H_{11}NO_2S$	5	0	149.21	0	0.0%	4.10E+09	0.00E+00	0.0%	b
Arginine	$C_6H_{14}N_4O_2$	6	0	174.2	0	0.0%	5.00E+09	0.00E+00	0.0%	b
Glycolic	$C_2H_4O_3$	2			51.8	2.9%	7.00E+08	1.00E+07	1.8%	
Glycerol	$C_3H_8O_3$	3			8.2	0.5%	1.90E+09	2.87E+06	0.5%	
Phthalic	$C_8H_4O_4$	8			43	2.4%	5.90E+09	1.75E+07	3.2%	
Levoglucosan	$C_6H_{10}O_5$	6			78.5	4.3%	2.40E+09	1.74E+07	3.1%	

Identified: 1809.8 100.0% Sum: **5.54E+08** 100.0%

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **1.46**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

Table S4j. Calculation of $k_{C,OH}$ for Asian aerosol particles from Mader et al.[29]

Sample D

Species	Molecular formula	Carbon #, n(C)	Conc. (pmol/m^3)	M.W. (g/mol)	Conc. (ng m^{-3})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Formate	$HCOO^-$	1			92	10.1%	3.50E+09	3.53E+08	70.1%	
Acetate	CH_3COO^-	2			87	9.5%	8.50E+07	4.05E+06	0.8%	
Lactate	$C_3H_6O_3$	3			133	14.6%	7.77E+08	3.77E+07	7.5%	
MSA	CH_4O_3S	1			14	1.5%	5.40E+07	8.28E+05	0.2%	
Oxalate	$C_2O_4^{2-}$	2			228	25.0%	4.70E+07	5.87E+06	1.2%	
Malonate	$C_3H_4O_4$	3			51	5.6%	2.00E+07	3.72E+05	0.1%	
Maleate	$C_4H_4O_4$	4			6	0.7%	6.00E+09	9.85E+06	2.0%	
Succinate	$C_4H_6O_4$	4			29	3.2%	3.10E+08	2.46E+06	0.5%	
Glutarate	$C_5H_8O_3$	5			27	3.0%	7.40E+08	4.37E+06	0.9%	
Glycine	$C_2H_5NO_2$	2	610	75.07	46	5.0%	1.70E+07	4.26E+05	0.1%	
Alanine	$C_3H_7NO_2$	3	112.2	89.09	10	1.1%	1.91E+08	6.95E+05	0.1%	
Proline	$C_5H_9NO_2$	5	60.9	115.13	7	0.8%	4.80E+08	7.37E+05	0.1%	
Cystine	$C_6H_{12}N_2O_4S_2$	6	67.1	240.3	16	1.8%	2.10E+09	6.18E+06	1.2%	
Threonine	$C_4H_9NO_3$	4	84.8	119.12	10	1.1%	5.10E+08	1.41E+06	0.3%	
2-Alanine	$C_3H_7NO_2$	3	54.7	89.09	5	0.5%	1.91E+08	3.39E+05	0.1%	
Glutamic acid	$C_5H_9NO_4$	5	84.5	147.13	12	1.4%	1.60E+08	4.36E+05	0.1%	
Aspartic acid	$C_4H_7NO_4$	4	73.8	133.1	10	1.1%	3.90E+09	1.05E+07	2.1%	b
Valine	$C_5H_{11}NO_2$	5	30.2	117.15	4	0.4%	7.55E+08	5.85E+05	0.1%	
Serine	$C_3H_7NO_3$	3	53.2	105.09	6	0.6%	2.50E+08	5.10E+05	0.1%	
2-Amino-butyric acid	$C_4H_9NO_2$	4	20.7	103.12	2	0.2%	5.30E+08	3.10E+05	0.1%	
Lysine	$C_6H_{14}N_2O_2$	6	38.7	146.19	6	0.6%	3.50E+08	3.61E+05	0.1%	
Leucine	$C_6H_{13}NO_2$	6	24.4	131.17	3	0.4%	1.50E+09	8.76E+05	0.2%	
Galactosamine	$C_6H_{13}NO_5$	6	5.5	179.171	1	0.1%	5.00E+09	8.99E+05	0.2%	b

Tyrosine	$C_9H_{11}NO_3$	9	30.7	181.19	6	0.6%	1.30E+10	8.80E+06	1.8%	
Ornithine	$C_5H_{12}N_2O_2$	5	19.3	132.16	3	0.3%	1.08E+08	6.00E+04	0.0%	
Isoleucine	$C_6H_{13}NO_2$	6	16	131.17	2	0.2%	1.80E+09	6.89E+05	0.1%	
Phenylamine	$C_6H_5NH_2$	6	13.7	93.13	1	0.1%	1.29E+10	3.00E+06	0.6%	
Histidine	$C_6H_9N_3O_2$	6	14.1	155.15	2	0.2%	4.80E+09	1.92E+06	0.4%	
Methionine	$C_5H_{11}NO_2S$	5	11.5	149.21	2	0.2%	4.10E+09	1.54E+06	0.3%	b
Arginine	$C_6H_{14}N_4O_2$	6	0	174.2	0	0.0%	5.00E+09	0.00E+00	0.0%	b
Glycolic	$C_2H_4O_3$	2			15.6	1.7%	7.00E+08	5.98E+06	1.2%	
Glycerol	$C_3H_8O_3$	3			4	0.4%	1.90E+09	2.77E+06	0.6%	
Phthalic	$C_8H_4O_4$	8			8.4	0.9%	5.90E+09	6.78E+06	1.3%	
Levoglucosan	$C_6H_{10}O_5$	6			65.8	7.2%	2.40E+09	2.88E+07	5.7%	

Identified: 913.5 100.0% Sum: **5.03E+08** 100.0%

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **1.32**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

Table S4k. Calculation of $k_{C,OH}$ for Asian aerosol particles from Mader et al.[29]

Sample E

Species	Molecular formula	Carbon #, n(C)	Conc. (pmol/m^3)	M.W. (g/mol)	Conc. (ng m^{-3})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Formate	$HCOO^-$	1			12	3.2%	3.50E+09	1.12E+08	49.4%	
Acetate	CH_3COO^-	2			23	6.1%	8.50E+07	2.60E+06	1.1%	
Lactate	$C_3H_6O_3$	3			11	2.9%	7.77E+08	7.56E+06	3.4%	
MSA	CH_4O_3S	1			11	2.9%	5.40E+07	1.58E+06	0.7%	
Oxalate	$C_2O_4^{2-}$	2			172	45.7%	4.70E+07	1.07E+07	4.8%	
Malonate	$C_3H_4O_4$	3			23	6.1%	2.00E+07	4.07E+05	0.2%	
Maleate	$C_4H_4O_4$	4			3	0.8%	6.00E+09	1.19E+07	5.3%	
Succinate	$C_4H_6O_4$	4			17	4.5%	3.10E+08	3.50E+06	1.5%	
Glutarate	$C_5H_8O_3$	5			12	3.2%	7.40E+08	4.72E+06	2.1%	
Glycine	$C_2H_5NO_2$	2	205.1	75.07	15	4.1%	1.70E+07	3.48E+05	0.2%	
Alanine	$C_3H_7NO_2$	3	46.2	89.09	4	1.1%	1.91E+08	6.95E+05	0.3%	
Proline	$C_5H_9NO_2$	5	39.7	115.13	5	1.2%	4.80E+08	1.17E+06	0.5%	
Cysteine	$C_6H_{12}N_2O_4S_2$	6	24.2	240.3	6	1.5%	2.10E+09	5.40E+06	2.4%	
Threonine	$C_4H_9NO_3$	4	79.8	119.12	10	2.5%	5.10E+08	3.22E+06	1.4%	
2-Alanine	$C_3H_7NO_2$	3	24.6	89.09	2	0.6%	1.91E+08	3.70E+05	0.2%	
Glutamic acid	$C_5H_9NO_4$	5	42.5	147.13	6	1.7%	1.60E+08	5.31E+05	0.2%	
Aspartic acid	$C_4H_7NO_4$	4	15.2	133.1	2	0.5%	3.90E+09	5.24E+06	2.3%	b
Valine	$C_5H_{11}NO_2$	5	16.8	117.15	2	0.5%	7.55E+08	7.89E+05	0.3%	
Serine	$C_3H_7NO_3$	3	29	105.09	3	0.8%	2.50E+08	6.74E+05	0.3%	
2-Amino-butyric acid	$C_4H_9NO_2$	4	8	103.12	1	0.2%	5.30E+08	2.90E+05	0.1%	
Lysine	$C_6H_{14}N_2O_2$	6	18.5	146.19	3	0.7%	3.50E+08	4.19E+05	0.2%	
Leucine	$C_6H_{13}NO_2$	6	20	131.17	3	0.7%	1.50E+09	1.74E+06	0.8%	
Galactosamine	$C_6H_{13}NO_5$	6	6.6	179.171	1	0.3%	5.00E+09	2.62E+06	1.2%	b

Tyrosine	$C_9H_{11}NO_3$	9	10.4	181.19	2	0.5%	1.30E+10	7.23E+06	3.2%	
Ornithine	$C_5H_{12}N_2O_2$	5	16.3	132.16	2	0.6%	1.08E+08	1.23E+05	0.1%	
Isoleucine	$C_6H_{13}NO_2$	6	9.3	131.17	1	0.3%	1.80E+09	9.72E+05	0.4%	
Phenylamine	$C_6H_5NH_2$	6	7.4	93.13	1	0.2%	1.29E+10	3.93E+06	1.7%	
Histidine	$C_6H_9N_3O_2$	6	6.7	155.15	1	0.3%	4.80E+09	2.21E+06	1.0%	
Methionine	$C_5H_{11}NO_2S$	5	0	149.21	0	0.0%	4.10E+09	0.00E+00	0.0%	b
Arginine	$C_6H_{14}N_4O_2$	6	0	174.2	0	0.0%	5.00E+09	0.00E+00	0.0%	b
Glycolic	$C_2H_4O_3$	2			4.5	1.2%	7.00E+08	4.18E+06	1.9%	
Glycerol	$C_3H_8O_3$	3			6	1.6%	1.90E+09	1.01E+07	4.5%	
Phthalic	$C_8H_4O_4$	8			5.9	1.6%	5.90E+09	1.16E+07	5.1%	
Levoglucosan	$C_6H_{10}O_5$	6			7	1.9%	2.40E+09	7.43E+06	3.3%	

Identified: 376.6 100.0% Sum: **2.26E+08** 100.0%

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **0.59**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

Table S4l. Calculation of $k_{C,OH}$ for Asian aerosol particles from Mader et al.[29]

Sample F

Species	Molecular formula	Carbon #, n(C)	Conc. (pmol/m^3)	M.W. (g/mol)	Conc. (ng m^{-3})	% of ID'd DOC	Rate Constant, $k_{S,OH}$ (L mol-cmpd^{-1} s^{-1})	% ID'd × k/n(C) (L mol-C^{-1} s^{-1})	OH Scavenger Contribution	Note for rate constant [a]
Formate	$HCOO^-$	1			27	6.3%	3.50E+09	2.22E+08	62.7%	
Acetate	CH_3COO^-	2			19	4.5%	8.50E+07	1.90E+06	0.5%	
Lactate	$C_3H_6O_3$	3			48	11.3%	7.77E+08	2.92E+07	8.2%	
MSA	CH_4O_3S	1			14	3.3%	5.40E+07	1.78E+06	0.5%	
Oxalate	$C_2O_4^{2-}$	2			165	38.8%	4.70E+07	9.12E+06	2.6%	
Malonate	$C_3H_4O_4$	3			29	6.8%	2.00E+07	4.54E+05	0.1%	
Maleate	$C_4H_4O_4$	4			5	1.2%	6.00E+09	1.76E+07	5.0%	
Succinate	$C_4H_6O_4$	4			14	3.3%	3.10E+08	2.55E+06	0.7%	
Glutarate	$C_5H_8O_3$	5			17	4.0%	7.40E+08	5.91E+06	1.7%	
Glycine	$C_2H_5NO_2$	2	261.7	75.07	20	4.6%	1.70E+07	3.93E+05	0.1%	
Alanine	$C_3H_7NO_2$	3	51.7	89.09	5	1.1%	1.91E+08	6.88E+05	0.2%	
Proline	$C_5H_9NO_2$	5	49.2	115.13	6	1.3%	4.80E+08	1.28E+06	0.4%	
Cysteine	$C_6H_{12}N_2O_4S_2$	6	29.4	240.3	7	1.7%	2.10E+09	5.81E+06	1.6%	
Threonine	$C_4H_9NO_3$	4	0	119.12	0	0.0%	5.10E+08	0.00E+00	0.0%	
2-Alanine	$C_3H_7NO_2$	3	32.7	89.09	3	0.7%	1.91E+08	4.35E+05	0.1%	
Glutamic acid	$C_5H_9NO_4$	5	8.5	147.13	1	0.3%	1.60E+08	9.41E+04	0.0%	
Aspartic acid	$C_4H_7NO_4$	4	5.6	133.1	1	0.2%	3.90E+09	1.71E+06	0.5%	b
Valine	$C_5H_{11}NO_2$	5	11.6	117.15	1	0.3%	7.55E+08	4.82E+05	0.1%	
Serine	$C_3H_7NO_3$	3	2.4	105.09	0	0.1%	2.50E+08	4.94E+04	0.0%	
2-Amino-butyric acid	$C_4H_9NO_2$	4	8.8	103.12	1	0.2%	5.30E+08	2.83E+05	0.1%	
Lysine	$C_6H_{14}N_2O_2$	6	6.4	146.19	1	0.2%	3.50E+08	1.28E+05	0.0%	
Leucine	$C_6H_{13}NO_2$	6	14.2	131.17	2	0.4%	1.50E+09	1.09E+06	0.3%	
Galactosamine	$C_6H_{13}NO_5$	6	15.4	179.171	3	0.6%	5.00E+09	5.41E+06	1.5%	b

Tyrosine	$C_9H_{11}NO_3$	9	11.2	181.19	2	0.5%	1.30E+10	6.89E+06	1.9%	
Ornithine	$C_5H_{12}N_2O_2$	5	13.5	132.16	2	0.4%	1.08E+08	9.02E+04	0.0%	
Isoleucine	$C_6H_{13}NO_2$	6	3.8	131.17	0	0.1%	1.80E+09	3.52E+05	0.1%	
Phenylamine	$C_6H_5NH_2$	6	2.2	93.13	0	0.0%	1.29E+10	1.04E+06	0.3%	
Histidine	$C_6H_9N_3O_2$	6	1.3	155.15	0	0.0%	4.80E+09	3.79E+05	0.1%	
Methionine	$C_5H_{11}NO_2S$	5	0	149.21	0	0.0%	4.10E+09	0.00E+00	0.0%	b
Arginine	$C_6H_{14}N_4O_2$	6	0	174.2	0	0.0%	5.00E+09	0.00E+00	0.0%	b
Glycolic	$C_2H_4O_3$	2			9	2.1%	7.00E+08	7.41E+06	2.1%	
Glycerol	$C_3H_8O_3$	3			3	0.7%	1.90E+09	4.47E+06	1.3%	
Phthalic	$C_8H_4O_4$	8			7.2	1.7%	5.90E+09	1.25E+07	3.5%	
Levoglucosan	$C_6H_{10}O_5$	6			13.5	3.2%	2.40E+09	1.27E+07	3.6%	
				Identified:	425.4	100.0%	Sum:	**3.54E+08**	100.0%	

Calculated $k_{C,OH}$ for identified organics / Atmospheric water average value: **0.93**

Notes:
See Table S4b for a description of columns.
[a] All rate constants from Ross et al.[24] except as noted.
[b] Used the average rate constant for organic compounds with the same carbon number from Ross et al.[24].

References

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