Supporting Information

Significant increase of aromatics-derived secondary organic aerosol during fall to winter in China

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Figures and Tables

Figure S1 (a) TIC of 2,3-dihydroxy-4-oxopentanoic acid spiked with citramalic acid. Black and blue lines indicate sample and authentic citramalic acid, respectively. The presented structures are not trimethylsilylated. (b) EI spectra of silylated DHOPA.

Figure S2 Correlations of DHOPA between paired sites within each region in the northern and southern China

Figure S3 Fire spots provide by Fire Information for Resource Management System (FIRMS, https://firms.modaps.eosdis.nasa.gov/firemap/) in (a) fall (October-November, 2012), (b) winter (December 2012-Februray 2013), (c) spring (March-May 2013) and (d) summer (June-September 2013).

Figure S4 Monthly variations of 12-site averages of DHOPA, levoglucosan and BSOA tracers (sum of isoprene, monoterpenes and β-caryophyllene)

Figure S5 Variation of DHOPA/SOA_A ratios with VOCs/NOx ratios. The blue circles indicate chamber results reported by Kleindienst et al. [1] The red shadow and line indicate the observed VOCs/NOx range and mean value, respectively, at a regional background site of the highly polluted Pearl River Delta, South China.[2]

Figure S6 Correlation coefficients (r) between DHOPA and PBL at 12 sites. The red and gray bars indicate significant ($p<0.05$) and poor ($p>0.05$) correlations, respectively.

Figure S7 Distribution of 12 sampling sites in China and 0.5°×0.5° Asia emissions of AHs in 2006 (0−447 M mol/year per grid) developed by Zhang et al.[3]

Figure S8 Cluster analyses of air masses at the BN and KM sites with 0.5°×0.5° Asia emissions of AHs in 2006 (0−447 M mol/year per grid) developed by Zhang et al.[3]

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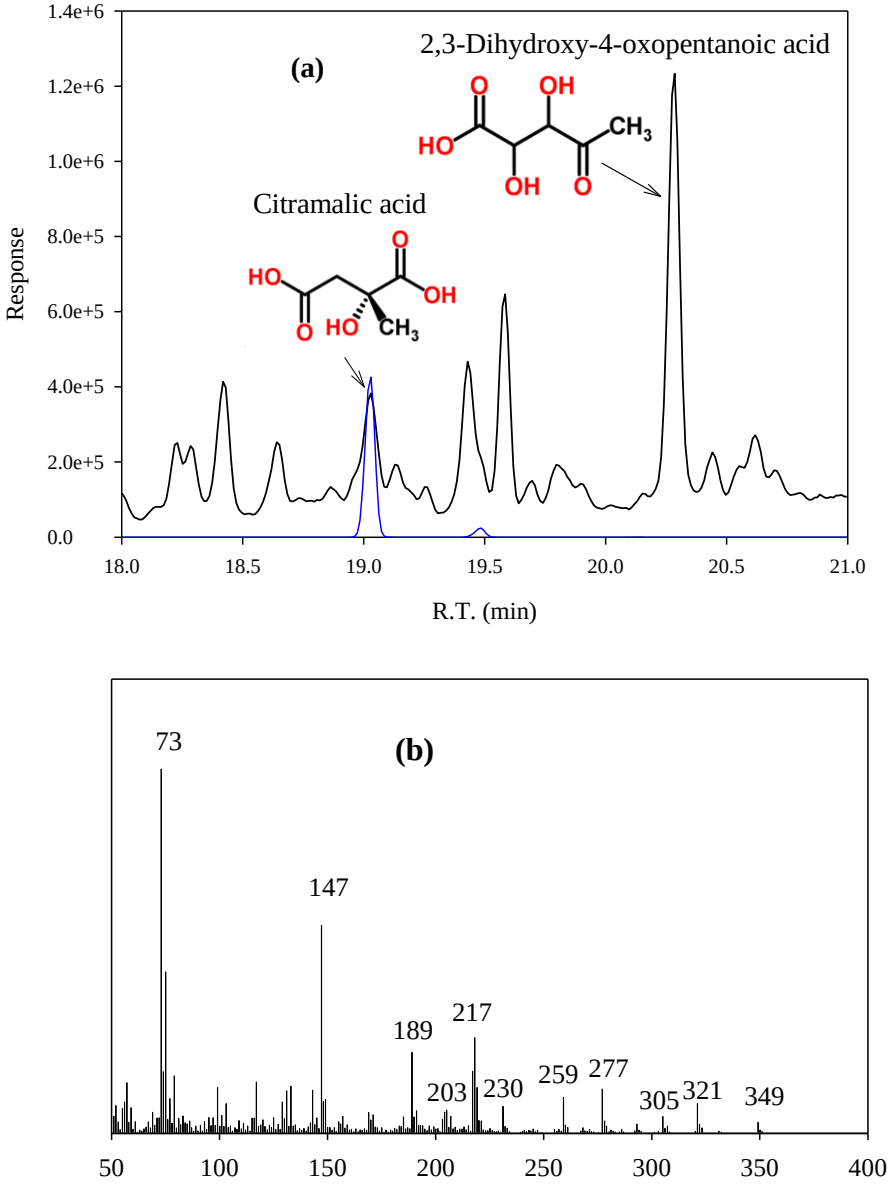
Table S2 Estimated saturation concentration (C*) and fractions in the particle-phase (ζ) for DHOPA

Table S3 Ratios for PBL and DHOPA at each site

Table S4 Rate constants and lifetimes of AHs with OH at 298 K



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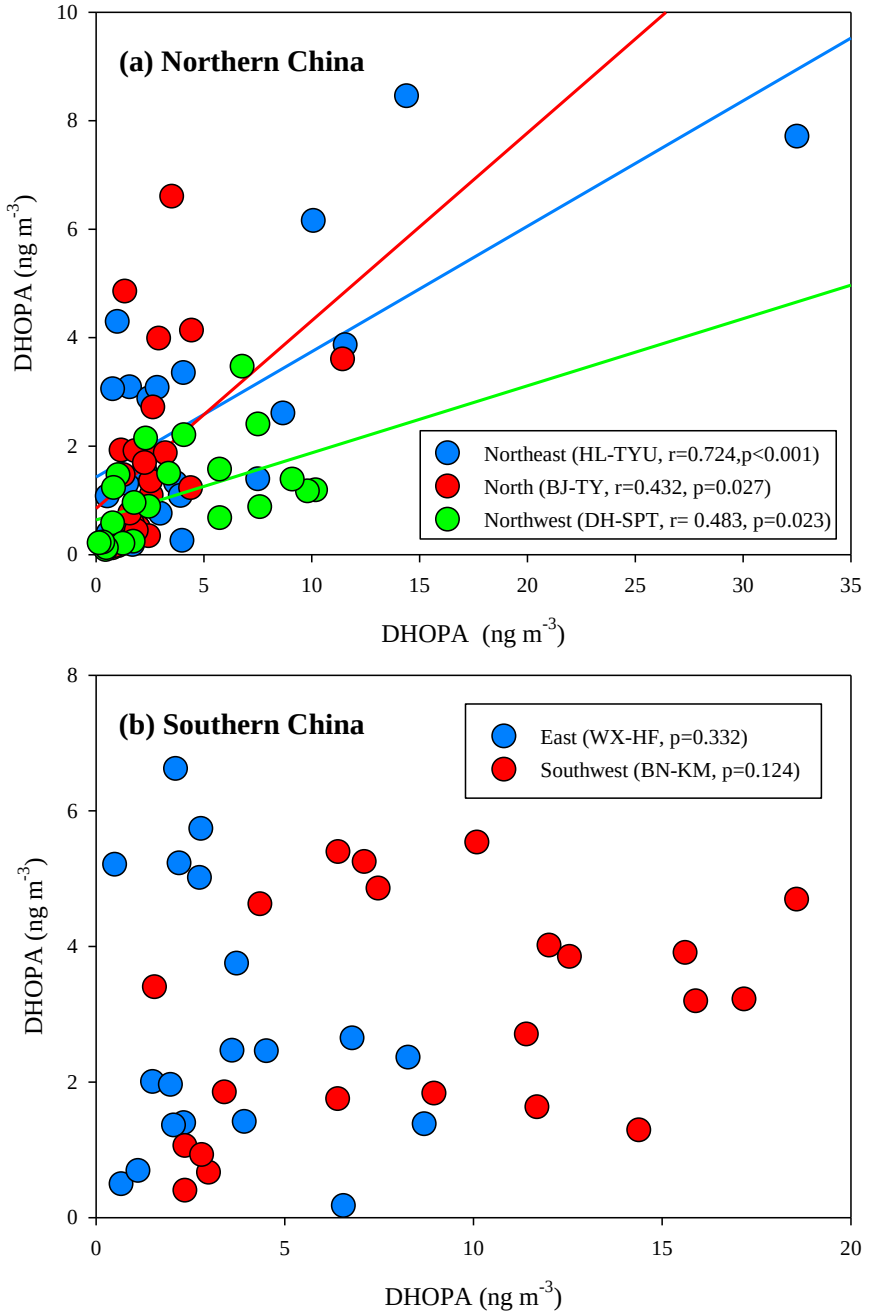

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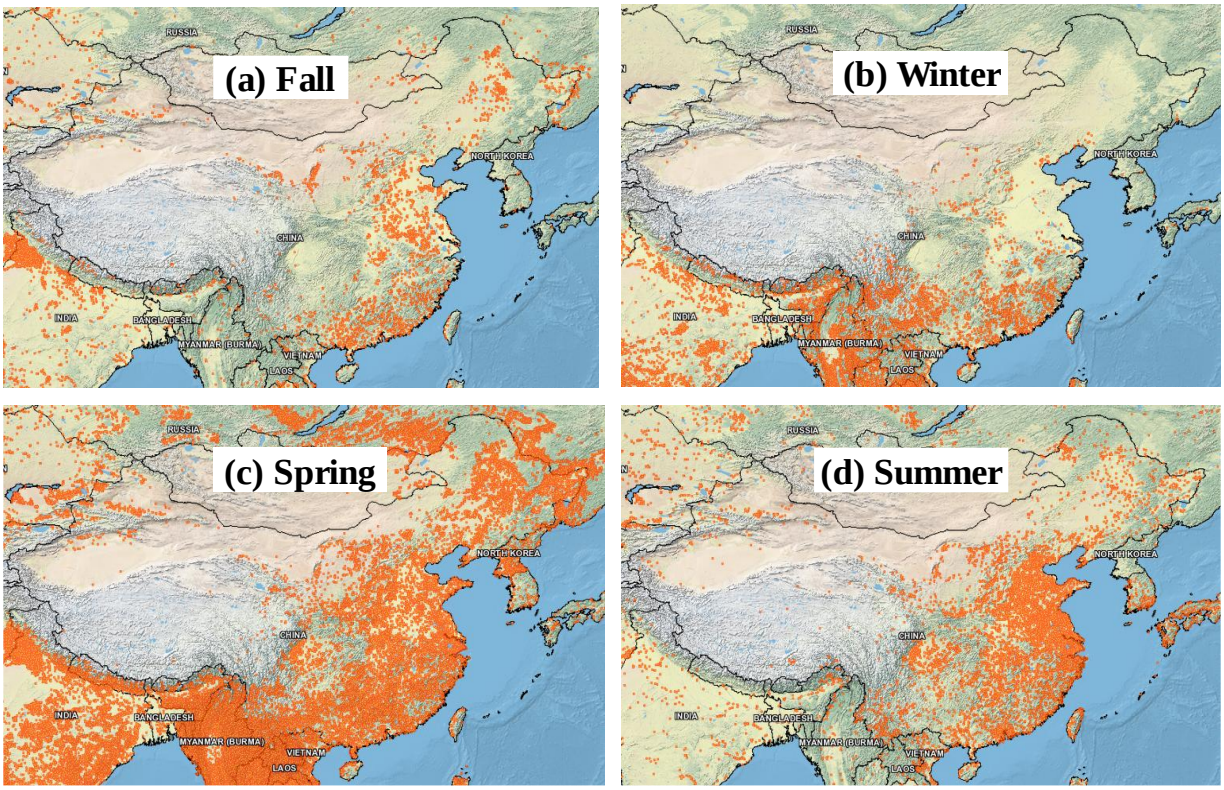

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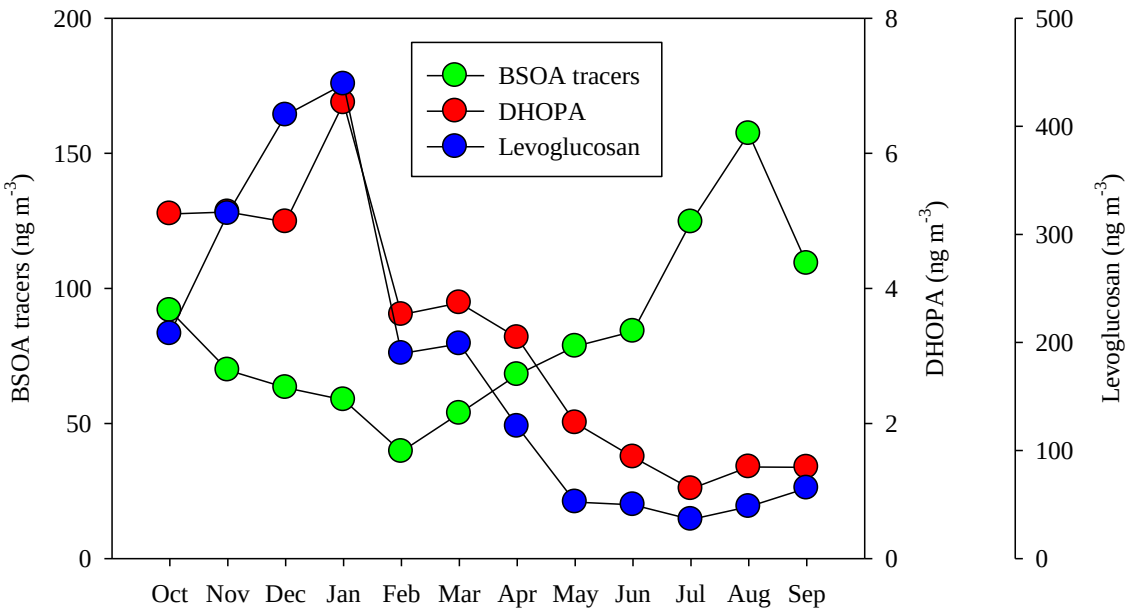

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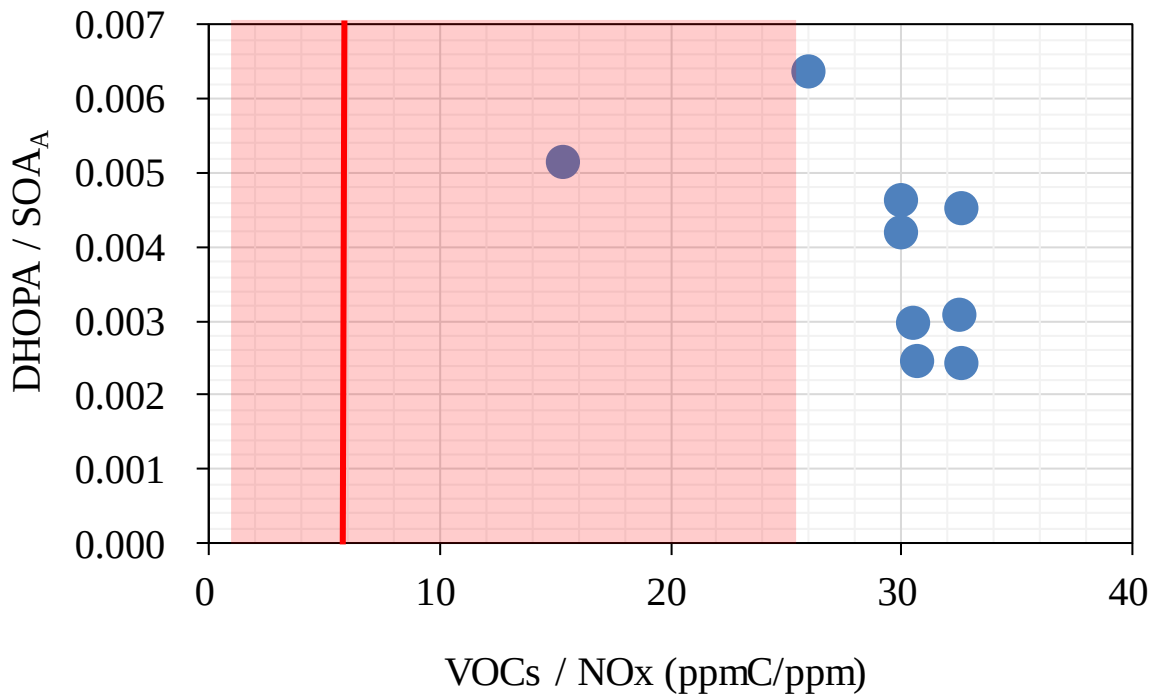

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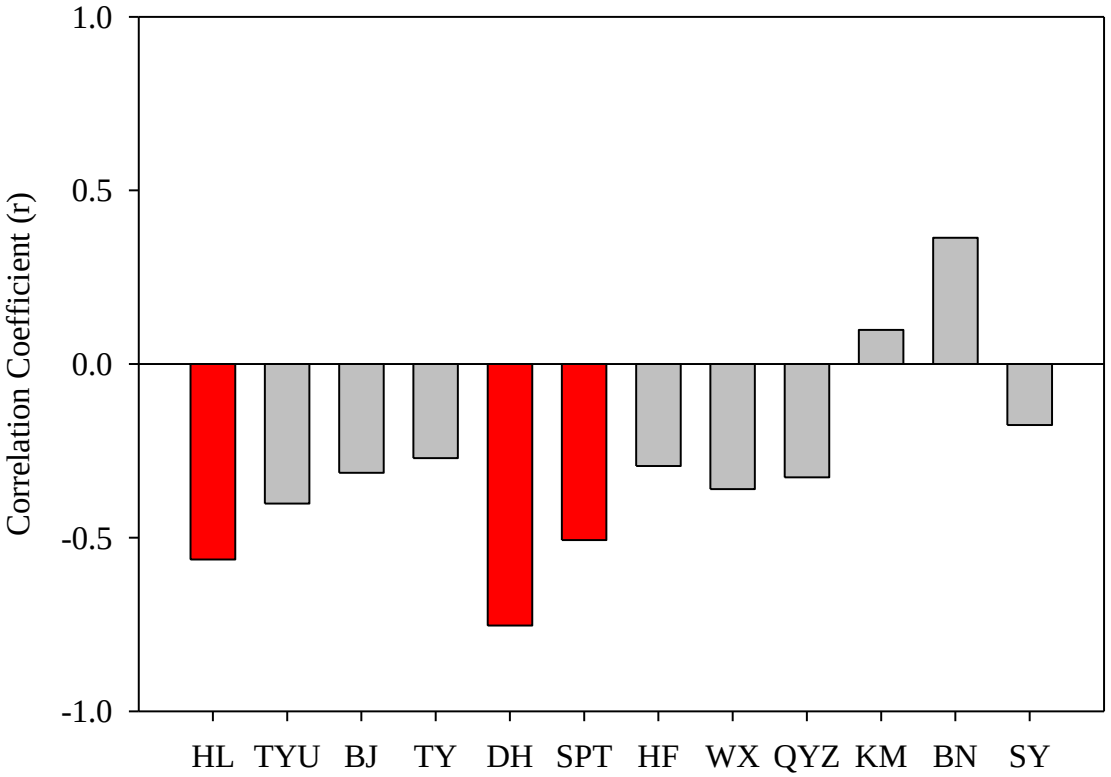

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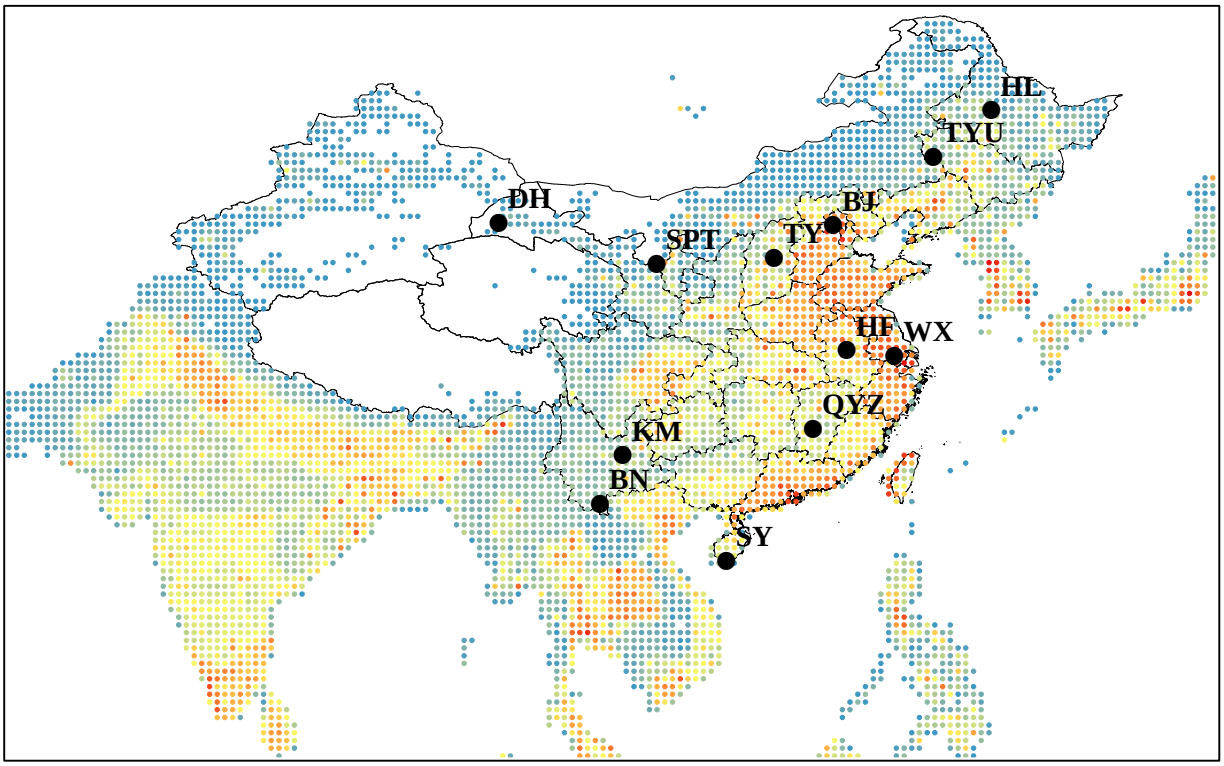

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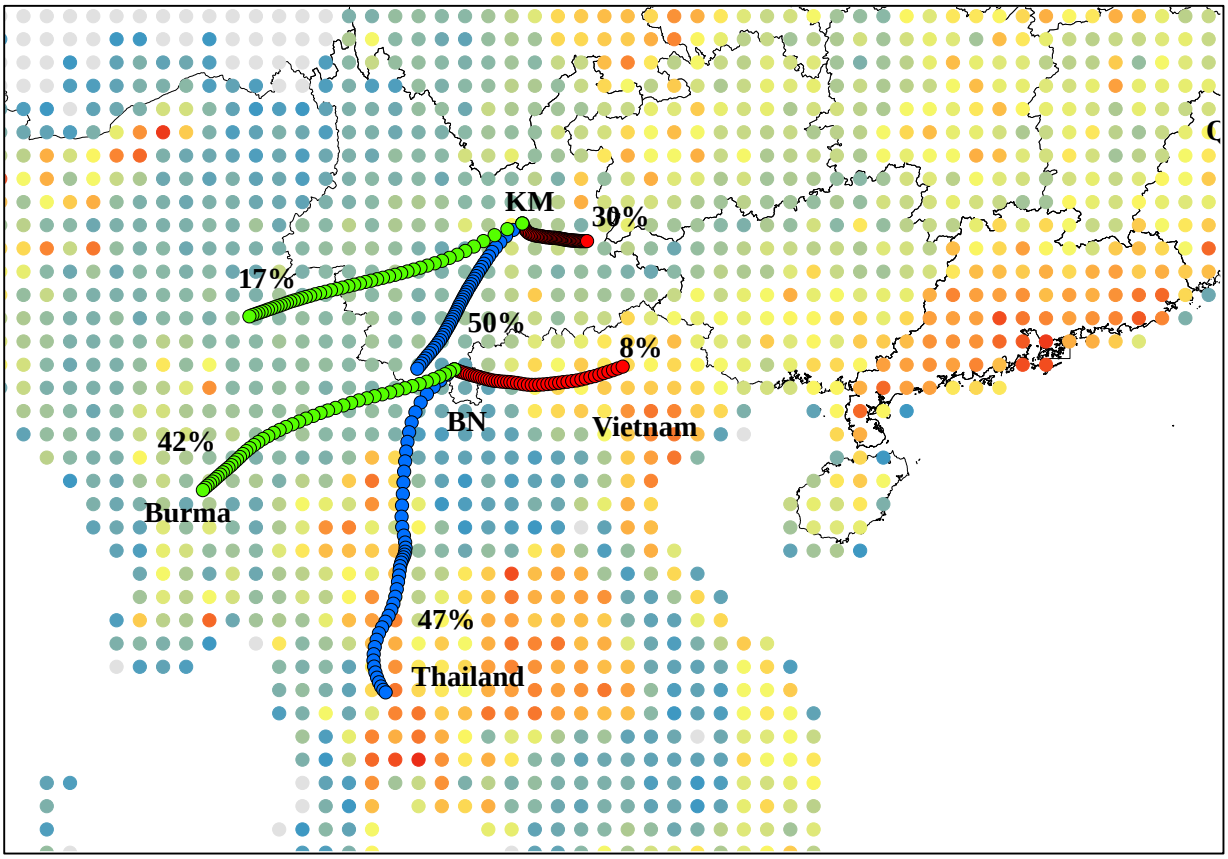

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Table S1 Summary of meteorological parameters and DHOPA at 12 sites

	Northeast China								North China								Northwest China							
	Hailun (HL)				Tongyu (TYU)				Beijing (BJ)				Taiyuan (TY)				Dunhuang (DH)				Shapotou (SPT)			
	Sub-urban				Rural				Urban				Urban				Urban				Rural			
	mean	median	min	max	mean	median	min	max	mean	median	min	max	mean	median	min	max	mean	median	min	max	mean	median	min	max
	Whole year																							
Temperature (℃)	1.4	2.0	-29.4	25.2	3.7	4.9	-22.7	25.1	12.4	13.4	-9.1	28.2	11.1	12.1	-8.4	26.3	10.9	14.9	-12.1	26.7	10.3	12.7	-8.3	24.8
RH (%)	76	77	52	100	63	67	24	91	55	53	14	89	55	53	26	92	35	35	17	70	46	44	16	87
Solar radiation (W m^{-2})	736	775	198	1145	735	759	403	1084	651	646	386	1002	720	717	261	1135	787	756	447	1220	754	700	420	1114
PBL (m)	474	453	96	981	571	540	117	1349	425	413	105	1088	518	500	131	1098	454	406	75	1247	670	666	123	1302
Visibility (km)	10	11	3	21	8	8	3	15	13	10	3	28	8	8	2	15	28	30	16	30	8	8	5	10
DHOPA (ng m^{-3})	5.23	2.95	0.57	32.5	2.98	2.59	0.17	10.6	2.52	1.96	0.79	11.5	1.72	1.28	0.11	6.59	3.68	2.34	0.19	10.2	1.23	1.16	0.07	4.04
	Fall																							
Temperature (℃)	-0.9	-0.4	-16.0	12.0	0.9	-1.9	-11.1	13.5	9.8	10.1	2.4	17.9	6.9	8.1	1.2	13.0	4.9	5.2	-3.1	15.6	5.6	5.7	-2.4	13.0
RH (%)	81	86	64	100	69	68	58	86	46	47	27	63	49	44	33	65	35	34	32	40	48	49	36	59
Solar radiation (W m^{-2})	448	424	198	673	523	472	440	709	561	560	434	671	435	552	448	750	642	628	515	772	626	603	554	724
PBL (m)	422	449	221	644	458	474	226	760	460	495	222	625	575	598	321	779	232	167	99	406	511	425	326	877
Visibility (km)	11	11	5	17	8	8	5	10	18	15	9	28	9	8	6	14	27	30	17	30	8	8	7	9
DHOPA (ng m^{-3})	4.99	4.13	1.60	10.1	5.78	4.74	3.08	10.57	1.90	1.38	1.20	2.95	2.97	2.70	1.45	4.84	7.79	7.59	5.77	10.2	2.01	1.56	0.87	4.04
	Winter																							
Temperature (℃)	-22.3	-20.3	-29.4	-18.7	-18.4	-18.3	-22.7	-13.5	-4.3	-3.6	-9.1	-1.5	-4.5	-4.7	-8.4	-1.2	-6.7	-7.0	-12.1	-1.4	-5.0	-4.5	-8.3	-1.2
RH (%)	76	73	72	88	63	67	47	76	51	49	32	78	59	48	40	92	48	50	24	70	42	41	31	53
Solar radiation (W m^{-2})	432	413	262	635	479	426	403	659	458	424	386	653	435	438	261	612	559	549	447	706	510	505	420	602
PBL (m)	165	129	96	266	207	162	117	353	234	182	105	573	262	238	131	485	112	118	75	149	212	181	123	379
Visibility (km)	6	5	3	15	6	5	3	10	12	9	3	26	5	4	2	11	30	30	30	30	6	6	5	8
DHOPA (ng m^{-3})	11.30	8.13	0.82	32.5	4.08	2.81	1.31	8.44	4.36	3.08	1.85	11.5	3.20	2.75	1.08	6.59	6.52	6.30	3.41	9.85	1.72	1.43	0.66	3.45
	Spring																							
Temperature (℃)	2.8	0.2	-11.4	20.1	5.7	3.3	-7.6	20.0	14.7	13.0	5.6	23.2	15.3	16.5	6.6	23.3	16.1	19.3	7.4	21.5	14.7	17.2	5.7	19.6
RH (%)	70	72	52	80	52	51	24	85	42	40	14	82	36	32	26	71	21	21	17	25	24	22	16	36
Solar radiation (W m^{-2})	934	918	697	1138	936	920	731	1084	799	836	639	960	966	971	793	1102	885	900	677	1056	929	907	799	1081
PBL (m)	574	611	233	907	866	866	189	1349	617	602	212	1088	715	665	346	1098	575	536	305	908	924	976	512	1349
Visibility (km)	12	12	6	21	9	10	7	12	13	10	6	28	9	9	7	14	26	27	16	30	8	8	5	10
DHOPA (ng m^{-3})	3.30	2.49	0.57	11.6	2.37	2.87	0.38	4.28	2.29	2.28	0.79	4.43	0.99	1.21	0.11	1.86	1.56	1.44	0.81	2.49	1.35	1.22	0.57	2.23
	Summer																							
Temperature (℃)	19.4	20.4	11.8	25.2	20.4	22.3	13.2	25.1	24.4	24.3	20.7	28.2	21.7	22.1	16.7	26.3	23.3	23.2	18.7	26.7	21.0	21.0	17.0	24.8
RH (%)	77	79	59	89	70	69	45	91	74	74	59	89	72	71	58	81	38	38	31	47	67	65	52	87
Solar radiation (W m^{-2})	972	981	818	1145	857	872	540	1045	723	754	515	1002	818	901	301	1135	962	1004	686	1220	864	926	584	1114
PBL (m)	651	611	426	981	657	622	460	937	378	383	226	520	503	417	291	951	743	673	440	1247	888	872	478	1302
Visibility (km)	12	11	10	19	10	10	4	15	10	10	4	19	8	8	5	15	29	30	26	30	9	9	7	10
DHOPA (ng m^{-3})	2.08	1.74	0.90	4.03	0.74	0.60	0.17	1.56	1.72	1.80	0.90	2.47	0.47	0.51	0.15	0.75	0.72	0.48	0.19	1.77	0.16	0.19	0.07	0.23

Table S1 Summary of meteorological parameters and DHOPA at 12 sites (continued)

	East China												Southwest China								South China			
	Hefei (HF)				Wuxi (WX)				Qianyanzhou (QYZ)				Kunming (KM)				Xishuangbanna (BN)				Sanya (SY)			
	Urban				Sub-urban				Rural				Urban				Rural				Sub-urban			
	mean	median	min	max	mean	median	min	max	mean	median	min	max	mean	median	min	max	mean	median	min	max	mean	median	min	max
	Whole year																							
Temperature (℃)	17.0	18.9	0.9	32.5	17.3	19.1	0.9	33.5	20.0	21.2	3.5	33.7	16.6	16.9	9.3	22.8	23.0	23.3	18.0	26.4	23.1	23.5	17.4	26.8
RH (%)	75	74	51	97	69	68	54	90	77	78	48	95	66	66	43	88	76	79	56	83	91	93	79	100
Solar radiation (W m^{-2})	736	793	105	1202	719	748	81	1224	789	860	119	1423	970	931	637	1304	988	969	578	1335	1052	1080	594	1374
PBL (m)	501	544	249	754	487	486	296	742	472	477	216	989	658	621	305	1263	507	451	205	1021	520	506	302	745
Visibility (km)	7	7	2	13	7	7	2	17	6	6	2	10	12	13	7	19	19	19	12	25	14	14	11	17
DHOPA (ng m^{-3})	2.70	2.17	0.16	6.61	2.98	2.43	0.52	8.72	3.48	2.38	0.14	14.1	2.71	2.69	0.39	5.52	8.83	7.50	1.57	18.6	3.65	3.19	0.37	14.3
	Fall																							
Temperature (℃)	13.9	14.8	6.6	20.1	14.4	15.2	6.7	20.8	17.4	18.9	10.8	23.6	15.5	15.6	13.3	18.6	23.0	23.4	21.9	24.1	23.2	23.0	22.7	24.2
RH (%)	76	75	64	89	67	71	54	78	78	79	62	94	74	71	67	86	81	82	77	83	87	84	82	98
Solar radiation (W m^{-2})	566	574	298	822	644	646	512	818	766	837	332	1038	868	923	637	968	1029	1006	840	1188	1090	1080	1065	1135
PBL (m)	433	445	273	616	492	491	428	551	390	375	216	498	538	588	367	715	403	408	327	480	580	572	480	720
Visibility (km)	6	7	3	9	6	6	4	8	5	5	3	7	12	13	7	14	17	18	14	20	14	15	12	17
DHOPA (ng m^{-3})	4.30	4.37	1.86	6.61	2.88	2.77	2.13	3.75	7.18	6.26	3.66	14.1	4.67	4.85	3.21	5.38	11.4	7.50	6.44	18.6	5.61	4.98	4.07	8.24
	Winter																							
Temperature (℃)	2.6	2.3	0.9	5.4	3.6	3.4	0.9	6.9	8.5	7.4	3.5	18.7	11.0	10.2	9.3	14.8	19.3	18.9	18.0	22.3	19.8	20.2	17.4	21.7
RH (%)	79	82	51	95	75	79	56	87	87	88	79	94	58	57	50	67	74	74	66	80	87	87	79	93
Solar radiation (W m^{-2})	345	432	105	518	379	468	81	613	483	539	119	695	831	782	752	1013	832	831	742	972	977	943	893	1192
PBL (m)	427	390	249	602	483	481	355	638	357	360	242	469	683	645	493	956	539	528	389	713	483	450	302	644
Visibility (km)	4	5	2	6	4	4	2	7	3	4	2	5	14	13	10	19	17	17	16	19	15	15	13	17
DHOPA (ng m^{-3})	2.85	2.31	0.16	5.72	4.78	4.69	1.52	8.72	4.36	4.83	1.95	6.41	3.47	3.39	1.74	5.52	8.09	8.56	1.57	12.0	6.94	5.66	4.10	14.3
	Spring																							
Temperature (℃)	19.3	19.4	12.7	26.3	19.6	19.5	13.6	25.7	21.4	22.7	12.4	29.0	18.3	17.6	13.6	22.8	23.9	23.2	20.8	26.4	23.6	23.7	17.4	26.8
RH (%)	69	63	57	89	63	59	54	75	77	75	60	94	55	55	43	64	69	70	56	80	92	94	83	95
Solar radiation (W m^{-2})	878	920	695	1038	936	961	738	1027	862	903	332	1136	1134	1133	888	1287	996	975	848	1221	1074	1083	775	1344
PBL (m)	544	586	276	754	460	415	320	679	480	515	303	586	902	922	596	1263	733	764	431	1021	445	467	331	587
Visibility (km)	8	9	5	11	8	8	5	11	6	7	3	9	12	13	8	17	18	19	12	21	14	14	14	16
DHOPA (ng m^{-3})	2.16	2.40	1.40	2.45	3.08	3.63	1.19	4.10	2.14	2.15	1.32	3.23	2.89	3.18	1.28	4.61	11.9	12.6	4.37	15.9	2.50	1.82	1.23	5.54
	Summer																							
Temperature (℃)	27.7	28.4	20.9	32.5	28.1	27.6	21.8	33.5	29.2	30.2	22.0	33.7	20.0	20.0	17.0	22.3	25.2	25.6	23.2	25.7	25.2	25.5	23.9	26.2
RH (%)	77	81	56	97	69	64	58	90	67	67	48	95	75	75	63	88	79	80	76	82	95	94	92	100
Solar radiation (W m^{-2})	1012	1046	645	1202	887	933	241	1224	969	1032	248	1423	996	1003	715	1304	1073	1118	578	1335	1064	1125	594	1374
PBL (m)	561	587	286	717	509	495	296	742	601	585	258	989	501	501	305	695	350	356	205	453	578	618	369	745
Visibility (km)	8	9	4	13	10	9	4	17	8	8	5	10	11	11	9	14	22	22	19	25	14	13	11	16
DHOPA (ng m^{-3})	1.84	1.37	0.48	5.20	1.61	1.57	0.52	2.99	1.42	1.23	0.14	3.26	0.84	0.73	0.39	1.84	2.80	2.82	2.38	3.42	0.98	0.77	0.37	2.23

Table S2 Estimated saturation concentration (C*) and fractions in the particle-phase (ζ) for DHOPA

	DHOPA
Formula	$C_5H_8O_5$
$\log_{10}(C^0)$ [a]	-0.50
$\log_{10}(\gamma_{i,s})$ [a,b]	0.03
$\log_{10}(C^*)$ [c]	-0.47
ζ (%)	99.0−99.6

[a] C^0 and $\gamma_{i,s}$ are estimated using the group-contribution method developed by Donahue [4]. [b], $\gamma_{i,s}$ is estimated based a highly aged background aerosol with O:C = 0.75:1. [c], $C^* = C^0 \times \gamma_{i,s}$. [d], ζ is calculated using the estimated OM range (35−86 μg m^{-3}) among the 12 sites in China [5].

Table S3 Ratios for PBL and DHOPA at each site

Sites		**PBL**	**DHOPA**
		Highest day to lowest day	Highest value to lowest value
Northern China	HL	10.2	57
	TYU	11.5	63
	BJ	10.4	14
	TY	8.40	63
	DH	16.7	55
	SPT	10.6	54
Southern China	HF	3.03	40
	WX	2.50	17
	QYZ	4.57	98
	KM	4.14	14
	BN	4.99	12
	SY	2.46	39

Table S4 Rate constants and lifetimes of AHs with OH at 298 K [a]

	Benzene	**Toluene**	**Ethyl-benzene**	**m-Xylene**	**p-Xylene**	**o-Xylene**
Rate constants (cm^3 $molecules^{-1}$ s^{-1})	1.22×10^{-12}	5.63×10^{-12}	7.00×10^{-12}	2.31×10^{-11}	1.43×10^{-11}	1.36×10^{-11}
Lifetimes with OH (hrs) [b]	114	24. 7	19.8	6.01	9.71	10.2
Lifetimes in the air (days) [c]	9.52	2.06	1.65	0.50	0.81	0.85

[a] Rate constants are provided by MCMv3.2 (http://mcm.leeds.ac.uk/MCMv3.2).
[b] Lifetimes are estimated using summer average concentration of OH radical (~2×10^6 molecules cm^{-3}) in multiple locations of China [6-8].
[c] 12-hr day and 12-hr night.

References

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