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Large contributions of biogenic and anthropogenic sources to fine organic aerosols in Tianjin, North China

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Table S1. Concentrations of organic compounds detected in the atmosphere aerosols in Tianjin (ng m^{-3})

Compounds	Winter (n=85)								Summer (n=60)							
	Daytime				Nighttime				Daytime				Nighttime			
	Min	Max	Mean	SD[a]	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
I. *n*-Alkanes																
C_{18}	n.d.[b]	13.4	6.35	3.70	n.d.	14.7	6.74	4.03	0.91	8.42	4.86	2.30	1.00	23.4	4.61	4.00
C_{19}	1.91	15.4	7.82	3.67	2.19	34.8	9.86	6.15	1.10	9.21	3.93	1.88	0.96	11.8	3.23	2.10
C_{20}	2.01	37.8	12.9	7.73	2.68	76.3	19.3	15.0	1.06	7.59	3.52	1.67	0.94	15.7	3.10	2.58
C_{21}	3.80	83.4	25.1	17.1	7.34	118	39.2	29.3	2.39	15.8	7.70	3.34	2.73	36.8	6.86	6.19
C_{22}	4.86	135	35.7	28.0	6.78	143	54.3	38.8	1.14	13.8	5.08	2.32	1.70	15.6	4.20	2.59
C_{23}	6.66	165	43.3	34.3	10.2	154	64.9	42.6	1.89	12.9	6.79	2.65	2.34	40.1	6.69	6.96
C_{24}	10.1	147	40.9	30.1	9.78	146	60.8	38.6	1.95	21.7	7.23	4.50	1.90	16.7	6.23	3.78
C_{25}	9.78	148	41.8	30.6	11.2	154	62.0	38.6	2.78	45.8	11.3	9.48	2.49	29.6	10.2	7.67
C_{26}	3.27	91.9	26.4	18.6	5.30	89.1	39.0	23.8	1.53	70.6	12.5	16.2	1.93	45.7	11.7	12.2
C_{27}	7.26	79.2	25.3	16.4	6.85	83.6	35.4	21.8	2.54	84.5	16.2	19.4	2.51	59.2	15.5	15.4
C_{28}	2.67	44.1	13.5	9.16	2.33	49.7	19.0	12.2	1.09	90.7	14.2	21.5	1.44	65.2	14.0	17.0
C_{29}	5.33	72.8	22.0	14.9	5.06	74.4	28.5	18.4	1.44	83.7	15.2	19.8	2.19	63.6	15.9	16.3
C_{30}	1.50	24.7	8.20	5.03	1.02	27.5	11.6	7.11	0.48	76.5	11.6	18.4	0.68	57.7	11.7	15.3
C_{31}	2.75	40.1	12.1	7.23	2.49	42.2	16.2	9.46	0.71	63.0	10.6	15.0	1.62	49.2	12.1	13.0
C_{32}	0.71	17.5	5.71	3.67	0.29	29.6	8.97	6.29	0.19	35.1	5.49	8.46	0.62	28.9	6.27	7.51
C_{33}	0.98	23.0	8.07	5.00	1.00	41.7	11.5	8.18	n.d.	14.7	3.18	3.56	0.77	27.3	4.60	5.18
C_{34}	0.45	16.0	4.75	3.59	0.06	24.3	6.83	5.40	n.d.	5.80	1.21	1.59	n.d.	11.8	2.06	2.36
C_{35}	0.31	10.2	3.49	2.44	0.54	16.5	5.14	3.43	n.d.	2.73	0.76	1.00	n.d.	15.7	1.59	2.89
subtotal	83.9	1152	343	227	85.1	1110	499	307	22.1	630	141	140	31.1	445	141	120
LMW(C_{19}-C_{24})[c]	36.1	592	172	118	44.0	662	255	169	10.8	69.0	39.1	14.1	15.9	137	34.9	23.3
HMW(C_{25}-C_{36})[d]	40.0	560	171	113	36.9	573	244	148	11.3	573	102	132	14.8	416	106	109
II. Fatty Acids																
$C_{12:0}$	3.45	36.8	12.9	6.75	2.69	42.1	15.1	8.66	1.11	11.8	5.50	2.66	0.69	37.8	5.64	6.28
$C_{13:0}$	1.42	18.9	6.81	3.79	1.53	14.4	7.21	3.08	1.12	7.88	4.20	1.49	1.63	11.3	4.38	2.27
$C_{14:0}$	4.76	55.4	15.3	8.84	3.73	35.7	17.2	8.34	5.46	25.5	15.8	5.52	4.07	56.6	17.9	12.1
$C_{15:0}$	2.40	18.6	8.53	4.04	2.01	23.8	10.5	5.49	2.66	15.1	8.23	3.48	0.89	56.3	8.79	11.4
$C_{16:0}$	3.54	1515	236	250	17.2	664	246	155	25.0	569	166	154	1.72	756	148	154
$C_{17:0}$	2.67	581	23.0	88.3	2.18	392	20.3	58.4	1.52	13.0	5.64	3.01	0.27	75.7	8.82	15.2
$C_{18:0}$	4.48	638	113	105	2.24	493	136	114	12.5	622	158	181	0.15	757	134	168
$C_{19:0}$	2.16	562	27.0	92.7	2.68	435	23.8	69.4	0.29	5.26	2.28	1.40	0.17	60.5	4.57	11.1
$C_{20:0}$	1.59	242	20.0	36.2	1.57	48.8	17.6	11.0	1.19	13.3	4.87	3.12	0.06	26.8	4.93	4.97
$C_{21:0}$	2.94	24.5	10.1	6.35	3.29	28.1	12.5	7.94	0.33	5.70	1.67	1.24	0.09	13.9	2.40	2.57
$C_{22:0}$	1.68	64.0	21.7	14.1	1.60	66.6	26.5	16.5	0.62	9.37	3.53	1.67	0.08	20.7	4.37	3.84
$C_{23:0}$	3.25	50.6	15.2	10.6	3.68	51.1	18.6	12.4	0.18	9.07	2.57	1.81	0.16	17.3	3.26	3.37
$C_{24:0}$	2.69	113	28.6	21.5	2.46	101	37.3	23.9	0.70	6.23	3.31	1.41	0.10	25.8	4.29	4.54
$C_{25:0}$	2.56	36.9	10.5	6.77	1.83	48.7	14.0	9.94	0.05	4.08	1.42	1.11	0.08	10.2	2.33	2.82
$C_{26:0}$	1.68	98.3	25.3	19.1	1.74	93.6	34.3	23.6	0.41	5.95	2.74	1.45	0.04	22.5	3.65	4.22
$C_{27:0}$	1.53	30.2	7.52	6.01	1.60	40.0	10.1	8.42	0.02	4.11	1.14	1.08	0.03	11.7	1.95	2.67
$C_{28:0}$	0.52	86.6	21.1	18.4	0.57	83.5	25.7	19.9	0.03	7.36	2.59	2.37	n.d.	22.5	3.65	4.98

$C_{29:0}$	0.23	23.7	7.50	5.09	0.19	29.8	8.79	7.16	0.05	4.48	0.90	1.10	n.d.	16.4	1.65	3.17
$C_{30:0}$	1.52	67.6	17.0	15.1	0.77	86.7	20.5	18.1	n.d.	5.26	1.82	1.47	n.d.	19.5	2.58	3.60
$C_{31:0}$	n.d.	13.8	4.37	3.25	0.63	23.8	5.64	5.00	n.d.	2.39	0.42	0.65	n.d.	7.79	0.83	1.66
$C_{32:0}$	n.d.	19.0	2.23	4.16	n.d.	20.5	2.35	4.08	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
$C_{16:1}$	n.d.	69.5	7.81	13.8	n.d.	58.3	11.3	14.4	n.d.	28.1	4.07	8.08	n.d.	30.7	5.07	7.69
$C_{18:1}$	n.d.	124	24.7	24.1	n.d.	372	55.7	70.8	n.d.	47.9	13.1	12.4	n.d.	53.5	14.5	13.3
subtotal	222	2090	666	418	124	1940	778	448	58.8	1280	410	354	92.2	1580	387	340
LMW(C_{12}-C_{19})	140	1850	442	353	91.1	1220	477	283	51.0	1260	366	340	77.0	1560	332	322
HMW(C_{20}-C_{32})	45.4	669	191	132	32.9	670	234	156	3.98	64.6	27.0	15.5	0.68	198	35.9	37.3
III. Fatty Alcohols																
C_{14}	14.7	349	101	78.4	16.8	385	131	105	13.4	80.8	52.4	18.8	18.2	267	51.1	45.4
C_{15}	5.91	205	62.4	50.5	9.54	249	76.4	61.5	10.8	59.6	33.8	12.6	11.2	216	31.9	36.6
C_{16}	79.3	1356	318	259	53.6	1068	348	226	30.9	539	183	147	42.9	700	167	146
C_{17}	4.01	354	53.3	59.9	9.48	231	57.5	50.6	5.43	51.5	22.8	11.4	2.07	118	20.0	20.4
C_{18}	62.8	1185	250	208	44.4	964	280	199	22.9	681	202	194	39.3	823	182	183
C_{19}	3.15	219	65.2	54.9	6.00	234	79.8	63.7	3.12	31.2	12.6	6.46	2.82	106	14.4	19.1
C_{20}	7.49	292	86.6	65.2	13.1	372	106	83.4	2.63	45.0	22.4	9.91	2.35	107	20.5	18.3
C_{21}	2.07	258	61.3	54.3	8.89	286	76.8	71.0	2.89	28.7	13.5	6.44	2.30	46.9	11.0	8.33
C_{22}	11.0	415	79.4	74.9	9.83	327	97.1	81.1	5.51	54.7	23.8	13.2	4.16	56.7	18.7	13.0
C_{26}	12.1	233	75.3	54.0	15.8	321	104	79.6	2.10	28.0	13.2	7.54	1.89	76.9	14.6	14.9
C_{28}	14.2	259	84.1	56.2	13.9	346	98.3	75.7	3.27	56.6	18.9	13.7	2.48	69.6	18.2	15.9
C_{30}	4.03	171	47.9	39.7	8.46	194	45.7	32.2	3.26	29.4	13.5	6.10	2.41	103	14.4	17.7
C_{32}	n.d.	81.8	20.2	15.5	n.d.	96.8	22.0	17.4	1.84	37.1	9.50	7.08	2.54	18.4	7.82	3.87
subtotal	369	3930	1305	811	234	4320	1522	1010	118	1530	621	367	196	2100	572	438
LMW(C_{12}-C_{19})	223	2830	850	566	142	2910	972	640	89.0	1320	506	351	139	1630	467	386
HMW(C_{20}-C_{32})	84.8	1400	455	308	92.2	1730	549	409	28.7	238	115	53.6	19.2	474	105	83.9
IV. Anhydrosugars																
galactosan	4.26	58.3	19.8	12.9	4.56	60.0	27.6	16.3	0.37	2.64	1.27	0.50	0.44	13.1	2.31	2.77
mannosan	5.61	84.2	29.2	16.9	8.50	102	43.0	25.2	0.70	5.08	2.71	1.15	1.07	24.1	4.56	4.70
levoglucosan	50.4	577	205	122	48.6	630	296	153	2.58	36.2	12.8	6.97	5.34	240	34.4	46.0
subtotal	66.1	720	254	150	61.8	788	367	191	3.65	43.3	16.8	8.33	7.15	268	41.2	52.6
V. Primary saccharides																
fructose	1.95	26.0	8.34	4.21	2.47	31.6	8.02	5.41	0.98	10.2	4.57	1.86	0.95	12.3	4.20	2.55
glucose	6.22	31.8	13.7	5.74	3.84	31.9	13.6	6.49	1.54	12.5	6.49	2.54	1.52	42.9	7.04	7.51
sucrose	1.03	23.5	5.19	4.69	1.41	13.1	3.92	2.52	0.07	35.4	4.11	6.65	0.04	47.2	4.10	8.57
trehalose	1.12	20.9	4.70	3.57	1.05	12.7	4.13	2.46	n.d.	6.33	1.79	1.61	n.d.	7.25	1.93	2.00
xylose	2.48	39.6	12.1	7.71	2.49	36.8	16.3	8.30	0.45	4.83	2.38	1.04	0.67	14.0	3.24	3.00
maltose	0.70	7.99	2.72	1.67	0.57	12.0	3.90	2.29	n.d.	1.75	0.72	0.47	n.d.	3.92	0.70	0.77
subtotal	19.7	106	46.8	20.9	12.9	133	49.9	24.0	4.74	63.5	20.1	11.1	3.96	125	21.2	21.5
VI. Sugar alcohols																
arabitol	1.00	13.0	3.88	3.08	0.63	13.6	4.83	3.22	0.17	6.45	1.83	1.66	0.15	8.75	1.92	2.04
mannitol	1.25	17.0	4.88	3.32	0.76	13.2	5.24	3.04	0.49	16.8	4.82	3.95	0.48	14.8	4.32	4.09
inositol	1.54	10.9	4.60	2.08	1.14	25.4	6.08	4.11	0.37	2.84	1.67	0.55	0.64	13.5	2.13	2.27
glycerol	13.0	181	49.8	32.0	8.32	121	52.8	27.1	5.11	46.1	14.8	10.8	5.86	185	25.0	31.9
erythritol	2.15	23.3	7.82	4.85	1.90	22.3	10.1	5.24	n.d.	2.55	1.20	0.66	n.d.	6.12	1.12	1.13

subtotal	20.5	234	71.0	42.8	15.2	157	60.0	29.5	8.71	50.2	24.3	10.6	11.7	223	34.5	37.0
total sugars	106	984	371	208	88.5	1063	496	247	17.5	101	61.2	21.1	29.7	503	96.9	94.0
VII. Isoprene SOA tracers																
2-methylglyceric acid	0.34	8.21	2.13	1.81	0.30	8.70	2.32	2.15	0.64	18.9	5.76	3.89	0.50	21.6	4.27	3.98
C_5-alkene triols[e]	0.10	5.54	1.57	1.47	0.06	7.70	1.82	1.86	1.18	39.1	11.7	11.5	1.29	40.7	10.4	9.83
2-methylthreitol	0.01	3.09	0.17	0.48	0.01	3.18	0.18	0.50	0.70	10.6	3.96	2.78	0.88	14.2	3.51	3.70
2-methylerythitol	0.03	4.49	0.26	0.69	0.02	3.45	0.23	0.54	1.11	22.1	8.12	5.93	1.70	29.9	7.12	7.48
subtotal	1.03	10.6	4.13	2.38	0.53	11.7	4.54	2.61	3.63	83.9	29.6	22.3	5.40	106	25.3	23.6
VIII. α/β-Pinene SOA tracers																
3-hydroxyglutaric acid	0.01	2.90	1.05	0.66	0.02	2.94	1.08	0.68	0.14	6.34	2.57	1.72	0.19	18.5	2.60	3.20
pinonic acid	0.08	17.1	5.43	3.54	0.37	10.5	4.80	2.41	2.47	44.6	11.1	8.89	1.71	44.1	8.60	7.49
pinic acid	0.51	17.1	4.78	4.14	0.52	12.8	4.58	3.39	0.58	19.7	6.42	4.65	0.10	58.1	7.55	10.5
MBTCA[f]	n.d.	6.10	0.91	1.07	0.03	4.65	0.93	0.92	n.d.	10.5	3.30	2.0	n.d.	18.2	3.65	3.62
subtotal	2.38	36.9	12.2	7.69	1.64	28.0	11.4	6.02	4.13	59.7	23.4	13.6	3.58	139	22.4	23.7
IX. β-Caryophyllene SOA tracers																
β-caryophyllinic acid	0.02	43.1	10.7	9.33	0.03	34.9	10.3	8.41	n.d.	6.79	1.99	1.81	n.d.	25.4	2.21	4.53
X. Anthropogenic SOA tracers																
phthalic acid	4.68	50.7	16.8	10.4	3.25	40.7	14.6	8.11	0.99	13.7	6.79	3.08	0.62	17.6	3.52	3.10
DHOPA[g]	0.87	10.3	4.36	2.48	0.66	8.71	4.30	2.22	n.d.	4.99	2.14	1.50	n.d.	14.6	1.67	2.66

[a]SD: standard deviation.

[b]n.d.: not detectable. We define those below the limit of detection (LOD) as n.d.. The LODs of organic compounds measured in this study were around 0.001-0.08 ng m^{-3}.

[c]LMW: low molecular weight.

[d]HMW: High molecular weight.

[e]C_5-alkane triols: *cis*-2-methyl-1,3,4-trihydroxy-1-butene, *trans*-2-methyl-1,3,4-trihydroxy-1-butene, and 3-methyl-2,3,4-trihyd roxy-1-butene.

[f]MBTCA: 3-methyl-1,2,3-butanetricarboxylic acid.

[g]DHOPA: 2,3-dihydroxy-4-oxopentanoic acid.

Table S2. Concentrations ratios of organic compounds detected in the atmosphere aerosols in Tianjin

Ratios	Winter (n=85)								Summer (n=60)							
	Daytime				Nighttime				Daytime				Nighttime			
	Min	Max	Mean	SD[a]	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD
I. *n*-Alkanes																
LMW/HMW[b]	0.52	1.76	1.03	0.30	0.57	1.88	1.04	0.32	0.10	2.01	0.83	0.50	0.07	1.13	0.56	0.32
WNA(%)[d]	3.97	19.2	10.1	3.39	3.80	16.6	9.01	3.16	0.07	41.6	10.2	8.44	n.d.[c]	40.8	9.91	8.20
CPI[d]	0.90	1.52	1.21	0.11	1.00	1.42	1.19	0.09	0.99	3.04	1.39	0.40	1.00	2.86	1.36	0.44
II. Fatty Acids																
$C_{18:0}/C_{16:0}$	0.04	1.27	0.55	0.21	0.04	1.19	0.55	0.22	0.39	1.39	0.77	0.28	n.d.	1.38	0.78	0.33
$(C_{16:1}+C_{18:1})/(C_{16:0}+C_{18:0})$	n.d.	0.40	0.10	0.09	n.d.	6.09	0.28	0.92	n.d.	0.25	0.08	0.08	n.d.	3.02	0.20	0.55
LMW/HMW	0.88	16.5	3.35	3.70	0.81	15.0	2.77	2.70	3.49	57.4	15.2	14.4	1.43	174	19.0	33.2
CPI[e]	0.30	22.3	2.96	3.12	0.41	3.61	2.62	0.65	1.52	8.59	3.09	1.55	0.29	4.11	2.53	1.04
III. Fatty Alcohols																
LMW/ HMW	0.93	8.56	2.36	1.93	1.08	7.76	2.06	1.23	1.78	31.4	5.32	5.94	1.86	31.6	5.55	5.84
IV. Sugars																
L/M[f]	4.88	19.8	7.32	2.68	5.10	15.4	7.44	2.46	2.74	8.08	4.71	1.29	2.99	15.8	6.65	2.47
M/G[g]	1.00	2.03	1.55	0.25	1.05	5.51	1.63	0.67	1.66	2.84	2.13	0.37	1.15	2.62	2.11	0.34
L/total	0.40	0.62	0.54	0.04	0.52	0.73	0.59	0.04	0.09	0.42	0.21	0.07	0.08	0.74	0.30	0.14
(primary + two polyols) /total	0.06	0.20	0.11	0.04	0.05	0.12	0.08	0.02	0.13	0.63	0.30	0.10	0.06	0.37	0.21	0.07
anhydrosugars/total	0.50	0.75	0.67	0.05	0.59	0.82	0.73	0.05	0.12	0.50	0.27	0.08	0.12	0.83	0.37	0.15
V. BSOA tracers																
2-MGA/MTLs[h]	0.13	75.2	17.0	20.0	0.13	104	22.0	27.9	0.18	1.20	0.54	0.26	0.07	1.31	0.50	0.28
$R_{iso/pine}$	0.11	1.17	0.39	0.20	0.08	3.93	0.52	0.61	0.36	6.00	1.85	1.19	0.51	5.14	1.77	1.27
(pinonic + pinic)/MBTCA[i]	1.16	79.0	17.6	15.9	0.90	241	31.0	51.9	2.82	38.0	6.76	7.01	2.08	53.4	7.27	9.74

[a]SD: standard deviation.

[b]LMW/HMW: the concentration rations of low molecular weight to high molecular weight.

[c]n.d.: not detectable. We define those below the limit of detection (LOD) as n.d.. The LODs of organic compounds measured in this study were around 0.001-0.08 ng m^{-3}.

[d]WNA, wax *n*-alkanes percentage are calculated as excess odd homologues - adjacent homologues average, and the difference from the total *n*-alkanes is the petroleum-derived amount. Negative values of plant wax *n*-alkanes were taken as zero.

Wax $C_n = C_n-[(C_{n+1}+C_{n-1})/2]$, when the $C_n < 0$, $C_n = 0$; (n were odd carbons); %Wax C_n = Wax $C_n/\Sigma C_n \times 100\%$

[e]CPI, Carbon Preference Index: $(C_{21} + C_{23} + C_{25} + C_{27} + C_{29} + C_{31} + C_{33})/ (C_{20} + C_{22} + C_{24} + C_{26} + C_{28} + C_{30} + C_{32} + C_{34})$ for *n*-alkanes; $(C_{20} + C_{22} + C_{24} + C_{26} + C_{28} + C_{30})/(C_{21}+ C_{23} + C_{25} + C_{27} + C_{29})$ for fatty acids.

[f]L/M: the concentration ratios of levoglucosan to mannosan.

[g]G/M: the concentration ratios of galactosan to mannosan.

[h]2-MGA/MTLs: the concentration ration of 2-methylglyceric acid to 2-methylthreitol and 2-methylerythitol.

[i]MBTCA: 3-methyl-1,2,3-butanetricarboxylic acid.

Table S3. Linear correlation coefficients (r) among saccharides during the wintertime 2016 in Tianjin.

Winter	levoglucosan	galactosan	mannosan	arabitol	fructose	glucose	mannitol	sucrose	trehalose	xylose	maltose	glycerol	erythritol
levoglucosan	1												
galactosan	0.92**	1											
mannosan	0.94**	0.95**	1										
arabitol	0.85**	0.83**	0.78**	1									
fructose	0.58**	0.56**	0.67**	0.48**	1								
glucose	0.77**	0.65**	0.66**	0.78**	0.64**	1							
mannitol	0.77**	0.79**	0.75**	0.82**	0.45**	0.79**	1						
inositol	0.81**	0.77**	0.83**	0.70**	0.76**	0.75**	0.72**						
sucrose	0.24*	0.28*	0.32**	0.27*	0.57**	0.42**	0.36**	1					
trehalose	0.58**	0.63**	0.57**	0.68**	0.34**	0.68**	0.87**	0.43**	1				
xylose	0.87**	0.75**	0.72**	0.85**	0.43**	0.82**	0.70**	0.12	0.52**	1			
maltose	0.89**	0.78**	0.80**	0.86**	0.53**	0.82**	0.77**	0.34**	0.63**	0.88**	1		
glycerol	0.73**	0.69**	0.59**	0.76**	0.37**	0.73**	0.62**	0.03	0.49**	0.84**	0.67**	1	
erythritol	0.94**	0.94**	0.89**	0.90**	0.52**	0.74**	0.80**	0.21*	0.60**	0.86**	0.83**	0.79**	1

Note.* denotes $\rho < 0.05$; ** denotes $\rho < 0.01$; Negative values indicate negative correlations.

Table S4. Linear correlation coefficients (r) among saccharides during the summertime 2017 in Tianjin.

Summer	levoglucosan	galactosan	mannosan	arabitol	fructose	glucose	mannitol	inositol	sucrose	trehalose	xylose	maltose	glycerol	erythritol
levoglucosan	1													
galactosan	0.96**	1												
mannosan	0.82**	0.92**	1											
arabitol	0.16	0.18	0.26*	1										
fructose	0.42**	0.50**	0.63**	0.43**	1									
glucose	0.46**	0.62**	0.83**	0.40**	0.80**	1								
mannitol	0.15	0.24	0.39**	0.92**	0.49**	0.57**	1							
inositol	0.46**	0.66**	0.84**	0.28*	0.62**	0.89**	0.47**	1						
sucrose	0.22	0.38**	0.53**	0.15	0.58**	0.75**	0.27*	0.74**	1					
trehalose	0.26*	0.35**	0.49**	0.83**	0.54**	0.63**	0.92**	0.55**	0.41**	1				
xylose	0.91**	0.94**	0.91**	0.33**	0.58**	0.65**	0.39**	0.66**	0.34**	0.51**	1			
maltose	0.52**	0.65**	0.78**	0.29*	0.61**	0.79**	0.49**	0.76**	0.58**	0.57**	0.71**	1		
glycerol	0.32*	0.51**	0.67**	-0.02	0.42**	0.72**	0.15	0.81**	0.66**	0.23	0.43**	0.55**	1	
erythritol	0.44**	0.61**	0.79**	0.41**	0.58**	0.81**	0.58**	0.80**	0.49**	0.66**	0.71**	0.79**	0.53**	1

Note.* denotes ρ < 0.05; ** denotes ρ < 0.01; Negative values indicate negative correlations.

Table S5. Linear correlation coefficients (r) among SOA tracers, T and RH during the wintertime 2016 in Tianjin.

Winter	2-MGA[a]	MTLs[b]	C_5-alkene triols[c]	3-HGA[d]	pinonic acid	pinic acid	MBTCA[e]	β-caryophyllinic acid	levoglucosan	phthalic acid	DHOPA[f]	T[g]	RH[h]
2-MGA	1												
MTLs	-0.15	1											
C_5-alkene triols	-0.22*	0.10	1										
3-HGA	0.36**	0.05	0.66**	1									
pinonic acid	0.47**	-0.11	0.09	0.54**	1								
pinic acid	0.41**	-0.12	0.40**	0.54**	0.56**	1							
MBTCA	0.57**	-0.03	0.04	0.37**	0.25*	0.41**	1						
β-caryophyllinic acid	0.07	0.06	0.50**	0.61**	0.41**	0.39**	0.01	1					
levoglucosan	0.35**	-0.02	0.54**	0.63**	0.44**	0.58**	0.12	0.53**	1				
phthalic acid	0.13	-0.05	0.17	0.40**	0.35**	0.18	0.12	0.60**	0.13	1			
DHOPA	0.39**	0.04	0.63**	0.89**	0.49**	0.56**	0.31**	0.70**	0.66**	0.52**	1		
T	0.42**	0.01	-0.19	0.09	0.29**	0.20	0.40**	-0.05	-0.03	-0.02	0.06	1	
RH	0.34**	0.04	0.03	0.20	0.02	0.15	0.34**	0.13	-0.05	0.46**	0.26*	0.15	1

Note.* denotes ρ < 0.05; ** denotes ρ < 0.01; Negative values indicate negative correlations.

[a]2-MGA: 2-methylglyceric acid.

[b]MTLs: 2-methylthreitol and 2-methylerythitol.

[c]C_5-alkene triols: *cis*-2-methyl-1,3,4-trihydroxy-1-butene, *trans*-2-methyl-1,3,4-trihydroxy-1-butene, and 3-methyl-2,3,4-trihydroxy-1-butene.

[d]3-HGA: 3-hydroxyglutaric acid.

[e]MBTCA: 3-methyl-1,2,3-butanetricarboxylic acid.

[f]DHOPA: 2,3-dihydroxy-4-oxopentanoic acid.

[g]T: temperature.

[h]RH: relative humidity.

Table S6. Linear correlation coefficients (r) among SOA tracers, T and RH during the summertime 2017 in Tianjin.

Summer	2-MGA	MTLs	C_5-alkene triols	3-HGA	pinonic acid	pinic acid	MBTCA	β-caryophyllinic acid	levoglucosan	phthalic acid	DHOPA	T	RH
2-MGA	1												
MTLs	0.72**	1											
C_5-alkene triols	0.77**	0.83**	1										
3-HGA	0.82**	0.69**	0.75**	1									
pinonic acid	0.58**	0.47**	0.46**	0.62**	1								
pinic acid	0.66**	0.51**	0.58**	0.91**	0.57**	1							
MBTCA	0.65**	0.53**	0.61**	0.80**	0.56**	0.86**	1						
β-caryophyllinic acid	0.72**	0.53**	0.56**	0.94**	0.59**	0.90**	0.75**	1					
levoglucosan	0.28*	0.19	0.17	0.38**	0.19	0.32*	0.22	0.38**	1				
phthalic acid	0.70**	0.53**	0.44**	0.68**	0.45**	0.59**	0.52**	0.67**	0.22	1			
DHOPA	0.77**	0.65**	0.57**	0.90**	0.59**	0.78**	0.69**	0.87**	0.41**	0.80**	1		
T	0.49**	0.59**	0.58**	0.31*	0.30*	0.20	0.31*	0.16	-0.07	0.47**	0.29*	1	
RH	-0.24	-0.29*	-0.19	-0.02	-0.13	-0.03	-0.22	0.02	0.02	-0.27*	-0.08	-0.73**	1

Note.* denotes ρ < 0.05; ** denotes ρ < 0.01; Negative values indicate negative correlations.

[a]2-MGA: 2-methylglyceric acid.

[b]MTLs: 2-methylthreitol and 2-methylerythitol.

[c]C_5-alkene triols: *cis*-2-methyl-1,3,4-trihydroxy-1-butene, *trans*-2-methyl-1,3,4-trihydroxy-1-butene, and 3-methyl-2,3,4-trihydroxy-1-butene.

[d]3-HGA: 3-hydroxyglutaric acid.

[e]MBTCA: 3-methyl-1,2,3-butanetricarboxylic acid.

[f]DHOPA: 2,3-dihydroxy-4-oxopentanoic acid.

[g]T: temperature.

[h]RH: relative humidity.

Table S7. Air quality data including AQI (μg m^{-3}), $PM_{2.5}$ (μg m^{-3}) and quality grad in the winter 2016 and summer 2017 in Tianjin.

Date	AQI	$PM_{2.5}$	Quality
2016/11/10	162	123	moderate pollution
2016/11/11	199	149	moderate pollution
2016/11/12	84.0	62.0	clean
2016/11/13	169	128	moderate pollution
2016/11/14	122	92.0	light pollution
2016/11/15	70.0	42.0	clean
2016/11/16	189	142	moderate pollution
2016/11/17	114	86.0	light pollution
2016/11/18	211	161	heavy pollution
2016/11/19	165	125	moderate pollution
2016/11/20	54.0	38.0	clean
2016/11/21	32.0	22.0	clean
2016/11/22	40.0	15.0	clean
2016/11/23	80.0	59.0	clean
2016/11/24	168	127	moderate pollution
2016/11/25	212	162	heavy pollution
2016/11/26	242	192	heavy pollution
2016/11/27	95.0	71.0	clean
2016/11/28	115	87.0	light pollution
2016/11/29	158	120	heavy pollution
2016/11/30	307	257	heavy pollution
2016/12/1	70.0	36.0	clean
2016/12/2	166	126	moderate pollution
2016/12/3	279	229	heavy pollution
2016/12/4	317	267	heavy pollution
2016/12/5	60.0	31.0	clean
2016/12/6	163	124	moderate pollution
2016/12/7	185	139	moderate pollution
2016/12/8	128	97.0	light pollution
2016/12/9	74.0	29.0	clean
2016/12/10	137	104	light pollution
2016/12/11	224	174	heavy pollution
2016/12/12	266	216	heavy pollution
2016/12/13	90.0	67.0	clean
2016/12/14	82.0	38.0	clean
2016/12/15	79.0	58.0	clean
2016/12/16	155	118	moderate pollution
2016/12/17	238	188	moderate pollution
2016/12/18	340	290	moderate pollution
2016/12/19	293	243	moderate pollution
2016/12/20	292	242	moderate pollution
2016/12/21	313	263	moderate pollution
2016/12/22	134	102	light pollution

2016/12/23	65.0	27.0	clean
2017/5/22	51.0	34.0	clean
2017/5/23	85.0	27.0	clean
2017/5/24	92.0	39.0	clean
2017/5/25	71.0	19.0	clean
2017/5/26	110	27.0	light pollution
2017/5/27	166	64.0	moderate pollution
2017/5/28	169	73.0	moderate pollution
2017/5/29	86.0	38.0	clean
2017/5/30	82.0	62.0	clean
2017/5/31	117	67.0	light pollution
2017/6/1	85.0	40.0	clean
2017/6/2	52.0	14.0	clean
2017/6/3	65.0	30.0	clean
2017/6/4	123	35.0	light pollution
2017/6/5	112	52.0	light pollution
2017/6/6	51.0	38.0	clean
2017/6/7	110	49.0	light pollution
2017/6/8	123	55.0	light pollution
2017/6/9	138	39.0	light pollution
2017/6/10	54.0	12.0	clean
2017/6/11	83.0	23.0	clean
2017/6/12	88.0	32.0	clean
2017/6/13	71.0	46.0	clean
2017/6/14	158	57.0	moderate pollution
2017/6/15	162	63.0	moderate pollution
2017/6/16	155	67.0	moderate pollution
2017/6/17	134	55.0	light pollution
2017/6/18	148	45.0	light pollution
2017/6/19	166	65.0	moderate pollution
2017/6/20	140	24.0	light pollution
2017/6/21	110	35.0	light pollution
2017/6/22	65.0	47.0	clean
2017/6/30	172	72.0	moderate pollution

Note. Excellent and good air qualities unify as clean days.

Table S8. Techniques for analyzing organic aerosols

Analysis targets	Techniques	References
OC, EC, WSOC	Thermal/optical reflectance, PILS-WSOC	El-Zanan et al., 2012
Organic molecules	HRMS (e.g. FTICR-MS)	Kourtchev et al., 2016
Small organic molecules	GC/MS, GC/FID, GCxGC/MS, LC/MS, LC/MS/MS, TOF/MS	Kourtchev et al., 2016; Stenson et al., 2002
Organic monomer isotopes	GC-IRMS, EA-MICADAS	Cao et al., 2017
Functional group; Molecules	NMR, FT/IR	Foley et al., 2013; Russell et al., 2011
Online observation	AMS, HR-AMS, CIMS	Chen et al., 2016
Fluorescence	UV-APS, WIBS, EEM-FS	Pöhlker et al., 2012

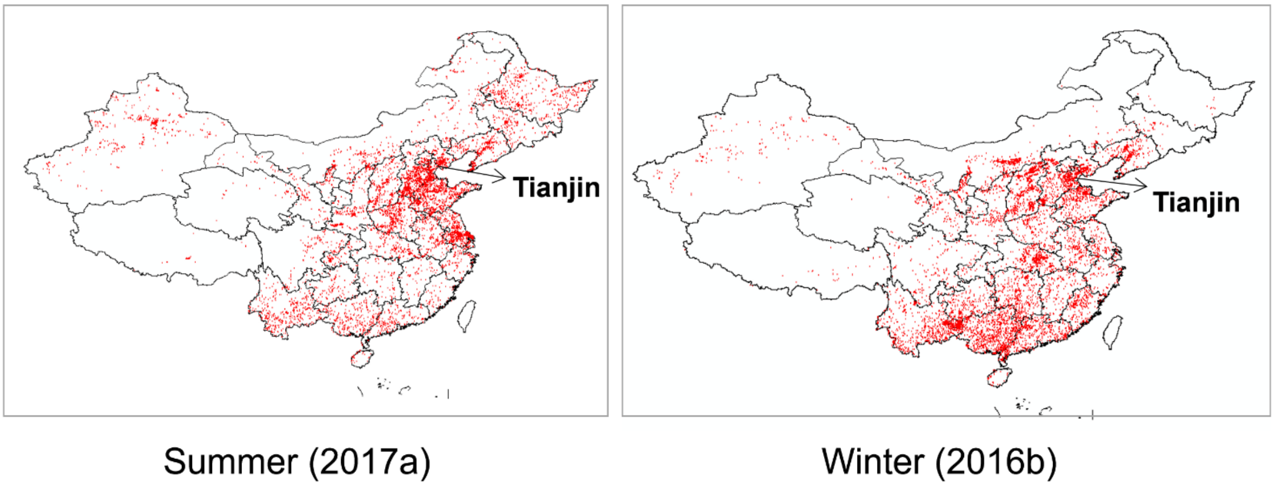

Figure S1: Fire maps during the summer 2017 and the winter 2016 in Tianjin.