The Aarhus Chamber Campaign on Highly Oxidized Multifunctional Organic Molecules and Aerosols (ACCHA): Particle Formation and
5 **Detailed Chemical Composition at Different Temperatures**

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Figure S1. Concentration of O_3 (ppb, black) and wall-loss corrected SOA mass ($\mu g m^{-3}$, red) and particle number (cm^{-3} , green, particle diameter: 10-400 nm, measured by SMPS) along with recorded RH (%) and Temperature ($^{\circ}C$, blue) during 10 ppb α -pinene oxidation experiments (Exp. 1.1-1.5)

Figure S2. Concentration of O_3 (ppb, black), α -pinene (ppb, dark green), and wall-loss corrected SOA mass ($\mu g m^{-3}$, red) and particle number (cm^{-3} , green, particle diameter: 10-400 nm, measured by SMPS) along with recorded RH (%) and temperature ($^{\circ}C$, blue) during 50 ppb α -pinene oxidation experiments (Exp. 2.1-2.3 (15 LMP VOC injection flow) & 3.1-3.2 (30 LMP VOC injection flow)).

Figure S3. O:C-ratios and concentrations ($\mu\text{g m}^{-3}$) of DTAA, DTA and MBTCA in SOA particles from 10 and 50 ppb α -pinene oxidation experiments performed at 20, 0, and -15 °C (Exp. 1.1-1.3 and Exp. 2.1-2.3).

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Table S1. Chemical formula, molecular weight (g mol⁻¹), and SOA particle concentration (ng m⁻³) of the identified organic acids and dimer esters in 10 ppb α -pinene oxidation experiment (Exp. 1.1-1.5). Percentages increase (green) or decrease (red) in concentrations compared to concentrations found in experiment performed at 20 °C (Exp. 1.1) are shown.

Experiment: Date: Temperature:			1.1 20161202 20 °C	1.2 20161207 0 °C	1.3 20161208 -15 °C	1.4 20161209 20 to -15 °C	1.5 20161212 -15 to 20 °C
Compound	Chemical Formula	Molecular weight	Conc. (ng m ⁻³)	Conc. (ng m ⁻³) Compared to 20 °C (%)	Conc. (ng m ⁻³) Compared to 20 °C (%)	Conc. (ng m ⁻³) Compared to 20 °C (%)	Conc. (ng m ⁻³) Compared to -15 °C (%)
Terebic acid	C ₈ H ₁₀ O ₄	170.16	73	101 +38	95 +30	100 +36	51 -46
Pinalic acid	C ₉ H ₁₄ O ₃	170.21	129	267 +106	779 +502	163 +26	238 -69
Terpenylic acid	C ₈ H ₁₂ O ₄	172.18	115	163 +42	170 +48	191 +66	48 -72
Pinonic acid	C ₁₀ H ₁₆ O ₃	184.23	122	200 +63	545 +346	153 +25	117 -79
Pinic acid	C ₉ H ₁₄ O ₄	186.20	308	556 +80	1374 +346	500 +62	492 -64
DTA	C ₈ H ₁₄ O ₅	190.19	94	31 -67	21 -78	49 -48	38 +84
Oxo-pinonic acid	C ₁₀ H ₁₄ O ₄	198.22	51	110 +116	308 +503	38 -25	37 -88
OH-pinonic acid	C ₁₀ H ₁₆ O ₄	200.23	58	171 +193	558 +855	110 +88	105 -81
MBTCA	C ₈ H ₁₂ O ₆	204.18	15	6 -59	4 -70	10 -34	3 -28
DTAA	C ₁₀ H ₁₆ O ₆	232.23	2	3 +54	2 -10	3 +52	1 -19
<i>Total organic acids</i>			967	1607 +66 %	3855 +299 %	1316 +36 %	1130 -71 %
Dimer ester MW 302	C ₁₅ H ₂₆ O ₆	302.36	33	7 -79	8 -76	6 -81	6 -27
Dimer ester MW 310	C ₁₇ H ₂₆ O ₅	310.38	9	8 -7	15 +69	4 -59	11 -23
Dimer ester MW 312	C ₁₆ H ₂₄ O ₆	312.35	24	13 -47	5 -79	9 -61	5 -1
Dimer ester MW 314	C ₁₆ H ₂₆ O ₆	314.37	16	3 -79	3 -84	11 -30	1 -71
Dimer ester MW 316	C ₁₅ H ₂₄ O ₇	316.34	3	0 -86	1 -84	1 -69	0 -10
Dimer ester MW 328	C ₁₆ H ₂₄ O ₇	328.35	7	3 -62	1 -87	3 -60	2 +146
Dimer ester MW 330	C ₁₆ H ₂₆ O ₇	330.37	6	3 -56	1 -85	3 -54	1 +22
Dimer ester MW 332	C ₁₅ H ₂₄ O ₈	332.34	1	0 -70	0 -61	1 -20	0 +33
Dimer ester MW 336	C ₁₉ H ₂₈ O ₅	336.41	16	26 +67	22 +40	6 -63	33 +49
Dimer ester MW 338	C ₁₉ H ₃₀ O ₅	338.43	31	54 +76	34 +9	17 -44	48 +41
Dimer ester MW 340	C ₁₈ H ₂₈ O ₆	340.40	39	29 -27	34 -13	17 -56	19 -45
Dimer ester MW 342	C ₁₇ H ₂₆ O ₇	342.38	69	32 -53	1 -98	62 -10	11 +928
Dimer ester MW 344	C ₁₇ H ₂₈ O ₇	344.39	9	4 -58	2 -77	4 -60	3 +58
Dimer ester MW 352	C ₁₉ H ₂₈ O ₆	352.41	108	101 -7	137 26	75 -31	72 -47
Dimer ester MW 354	C ₁₉ H ₃₀ O ₆	354.43	17	18 +7	13 -19	11 -32	12 -12
Dimer ester MW 356	C ₁₈ H ₂₈ O ₇	356.40	30	24 -18	15 -50	14 -52	16 +9
Dimer ester MW 358	C ₁₇ H ₂₆ O ₈	358.38	50	23 -55	4 -92	52 +3	5 +23
Dimer ester MW 360	C ₁₇ H ₂₈ O ₈	360.39	14	5 -61	3 -82	12 -12	1 -62
Dimer ester MW 362	C ₁₆ H ₂₆ O ₉	362.37	1	0 -81	0 -61	1 -40	0 -27
Dimer ester MW 368	C ₁₉ H ₂₈ O ₇	368.41	101	99 -2	141 +40	66 -34	125 -11
Dimer ester MW 370	C ₁₉ H ₃₀ O ₇	370.43	22	19 -13	13 -40	13 -40	10 -26
Dimer ester MW 372	C ₁₈ H ₂₈ O ₈	372.40	13	24 +85	3 -80	12 -5	8 +230
Dimer ester MW 374	C ₁₇ H ₂₆ O ₉	374.38	0	0 +195	0 +478	0 +191	0 -100
Dimer ester MW 378	C ₁₆ H ₂₆ O ₁₀	378.37	0	0 -66	0 -81	1 +15	0 +27
Dimer ester MW 384	C ₁₉ H ₂₈ O ₈	384.41	3	3 -18	3 -15	5 +58	3 +21
Dimer ester MW 386	C ₁₉ H ₃₀ O ₈	386.43	6	8 +39	2 -69	9 +58	1 -63
Dimer ester MW 388	C ₁₈ H ₂₈ O ₉	388.40	0	0	0	0	0
Dimer ester MW 400	C ₁₉ H ₂₈ O ₉	400.41	4	4 -7	1 -81	6 +38	2 +188
Dimer ester MW 406	C ₁₈ H ₃₀ O ₁₀	406.42	0	0 -66	1 +189	0 -23	0 -94
<i>Total Dimer esters</i>			633	511 -20 %	462 -27 %	422 -33 %	397 -14 %

Table S2. Chemical formula, molecular weight (g mol⁻¹), and SOA particle concentration (ng m⁻³) of the identified organic acids and dimer esters in 50 ppb α -pinene oxidation experiment (Exp. 2.1-2.3). Percentages increase (green) or decrease (red) in concentrations compared to concentrations found in experiment performed at 20 °C (Exp. 1.1) are listed. Also, data from experiments with increased α -pinene injection flow (Exp. 3.1 – 3.3) are shown.

Experiment:			2.1	2.2		2.3		3.1	3.2	3.3
Date:			20161212	20161219		20161213		20170112	20170116	20170113
Temperature:			20 °C	0 °C		-15 °C		20 °C	0 °C	-15 °C
Compound	Chemical Formula	Molecular weight	Conc. (ng m ⁻³)	Conc. (ng m ⁻³)	Compared to 20 °C (%)	Conc. (ng m ⁻³)	Compared to 20 °C (%)	Conc. (ng m ⁻³)	Conc. (ng m ⁻³)	Conc. (ng m ⁻³)
Terebic acid	C ₈ H ₁₀ O ₄	170.16	668	807	+38	503	+30	604	357	272
Pinalic acid	C ₉ H ₁₄ O ₃	170.21	960	3294	+106	3424	+502	928	2009	2868
Terpenylic acid	C ₈ H ₁₂ O ₄	172.18	874	1366	+42	1036	+48	925	765	795
Pinonic acid	C ₁₀ H ₁₆ O ₃	184.23	538	3501	+63	5030	+346	518	2630	3983
Pinic acid	C ₉ H ₁₄ O ₄	186.20	1934	6861	+80	8150	+346	2022	4186	5923
DTA	C ₈ H ₁₄ O ₅	190.19	366	257	-67	356	-78	372	172	153
Oxo-pinonic acid	C ₁₀ H ₁₄ O ₄	198.22	268	1184	+116	1130	+503	260	736	1040
OH-pinonic acid	C ₁₀ H ₁₆ O ₄	200.23	493	2800	+193	3615	+855	492	1636	2367
MBTCA	C ₈ H ₁₂ O ₆	204.18	100	16	-59	7	-70	131	8	14
DTAA	C ₁₀ H ₁₆ O ₆	232.23	36	36	+54	21	-10	42	21	10
Total organic acids			6237	20123	+222 %	23271	+273 %	6295	12521	17424
Dimer ester MW 302	C ₁₅ H ₂₆ O ₆	302.36	8	52	+589	22	+187	17	39	15
Dimer ester MW 310	C ₁₇ H ₂₆ O ₅	310.38	73	169	+130	81	+10	85	60	54
Dimer ester MW 312	C ₁₆ H ₂₄ O ₆	312.35	143	77	-46	19	-87	133	23	17
Dimer ester MW 314	C ₁₆ H ₂₆ O ₆	314.37	116	14	-88	12	-90	114	26	15
Dimer ester MW 316	C ₁₅ H ₂₄ O ₇	316.34	19	5	-75	2	-87	19	2	1
Dimer ester MW 328	C ₁₆ H ₂₄ O ₇	328.35	49	21	-56	2	-96	37	17	2
Dimer ester MW 330	C ₁₆ H ₂₆ O ₇	330.37	49	22	-54	27	-45	65	10	6
Dimer ester MW 332	C ₁₅ H ₂₄ O ₈	332.34	15	6	-64	7	-57	15	2	1
Dimer ester MW 336	C ₁₉ H ₂₈ O ₅	336.41	86	410	+379	189	+121	121	288	143
Dimer ester MW 338	C ₁₉ H ₃₀ O ₅	338.43	185	624	+238	298	+61	250	299	221
Dimer ester MW 340	C ₁₈ H ₂₈ O ₆	340.40	129	223	+73	265	+105	104	104	157
Dimer ester MW 342	C ₁₇ H ₂₆ O ₇	342.38	367	180	-51	52	-86	417	98	41
Dimer ester MW 344	C ₁₇ H ₂₈ O ₇	344.39	55	53	-3	29	-46	52	28	19
Dimer ester MW 352	C ₁₉ H ₂₈ O ₆	352.41	302	715	+137	790	+162	281	408	741
Dimer ester MW 354	C ₁₉ H ₃₀ O ₆	354.43	75	257	+243	201	+168	82	139	148
Dimer ester MW 356	C ₁₈ H ₂₈ O ₇	356.40	115	139	+21	100	-13	81	52	104
Dimer ester MW 358	C ₁₇ H ₂₆ O ₈	358.38	472	80	-83	24	-95	718	39	8
Dimer ester MW 360	C ₁₇ H ₂₈ O ₈	360.39	68	32	-53	12	-82	86	5	8
Dimer ester MW 362	C ₁₆ H ₂₆ O ₉	362.37	10	2	-80	2	-78	14	3	3
Dimer ester MW 368	C ₁₉ H ₂₈ O ₇	368.41	365	791	+116	1049	+187	440	423	1062
Dimer ester MW 370	C ₁₉ H ₃₀ O ₇	370.43	104	193	+86	111	+7	133	166	84
Dimer ester MW 372	C ₁₈ H ₂₈ O ₈	372.40	100	96	-4	17	-83	98	39	37
Dimer ester MW 374	C ₁₇ H ₂₆ O ₉	374.38	3	1	-78	2	-42	3	2	2
Dimer ester MW 378	C ₁₆ H ₂₆ O ₁₀	378.37	5	0	-92	1	-88	8	0	1
Dimer ester MW 384	C ₁₉ H ₂₈ O ₈	384.41	47	40	-14	14	-69	56	80	28
Dimer ester MW 386	C ₁₉ H ₃₀ O ₈	386.43	75	93	+25	10	-86	122	86	80
Dimer ester MW 388	C ₁₈ H ₂₈ O ₉	388.40	10	0	-100	0	-100	23	10	6
Dimer ester MW 400	C ₁₉ H ₂₈ O ₉	400.41	26	15	-41	1	-98	70	129	36
Dimer ester MW 406	C ₁₈ H ₃₀ O ₁₀	406.42	1	6	+552	7	+642	1	5	7
Total Dimer esters			3073	4482	+46 %	3346	-9 %	3741	2661	3108