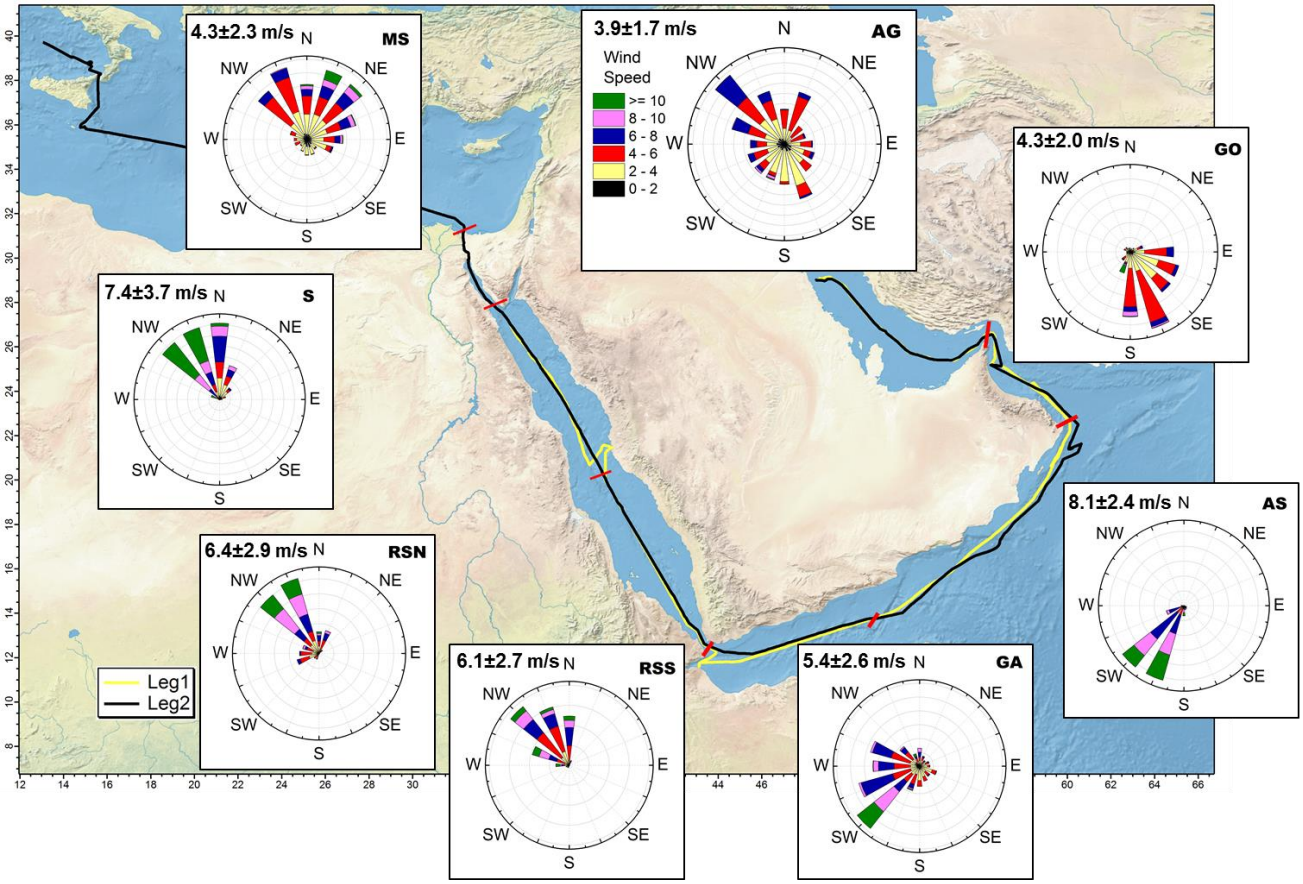

Figure S1. Wind map of each area and ship cruise. The number on the left top of each map represents the mean ± standard deviation of the wind speed in each area. The data used for map plotting was from public domain GIS data found on the Natural Earth web site (http://www.naturalearthdata.com) was read into Igor using the IgorGIS XOP beta.

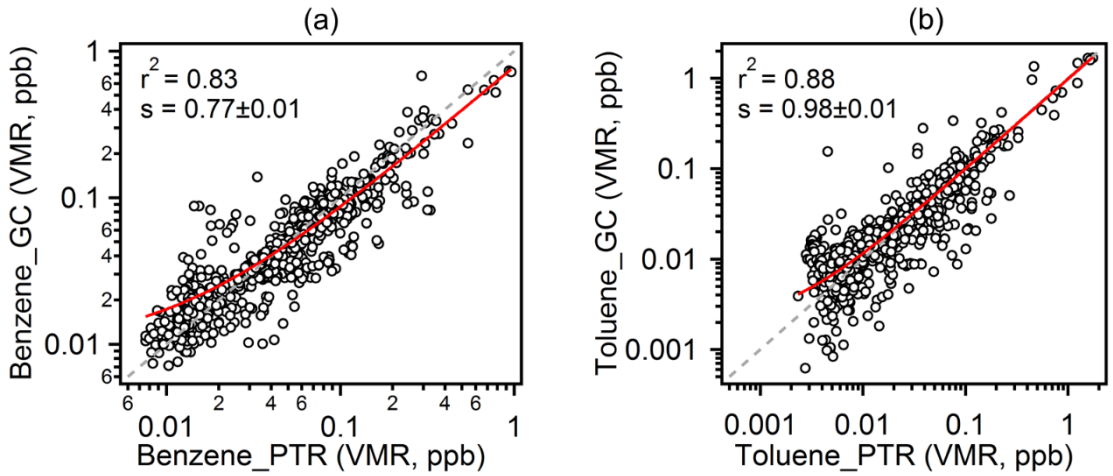

Figure S2. Comparison of (a) benzene and (b) toluene measured by GC-FID and PTR-ToF-MS (data from PTR-Tof-MS was averaged to GC time resolution of 50 min).

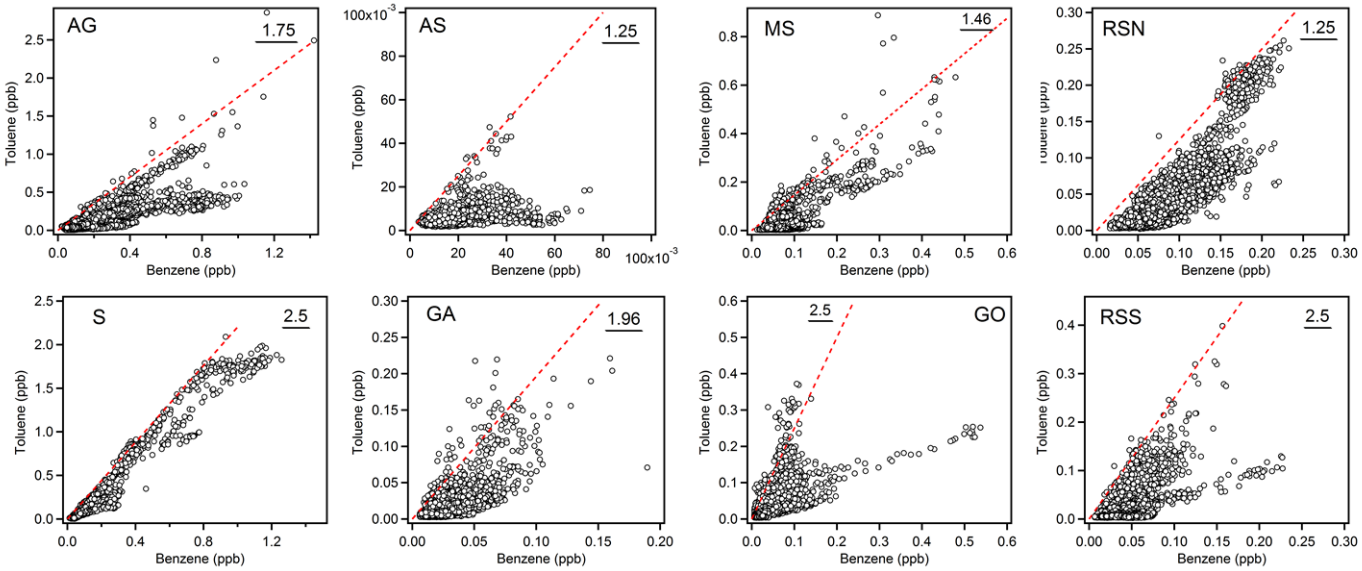

Figure S3. Scatter plots between benzene and toluene mixing ratios for the eight regions. Red dashed line represents the emission ratio (values with underlined numbers on the top right of each figure) determined for further calculation.

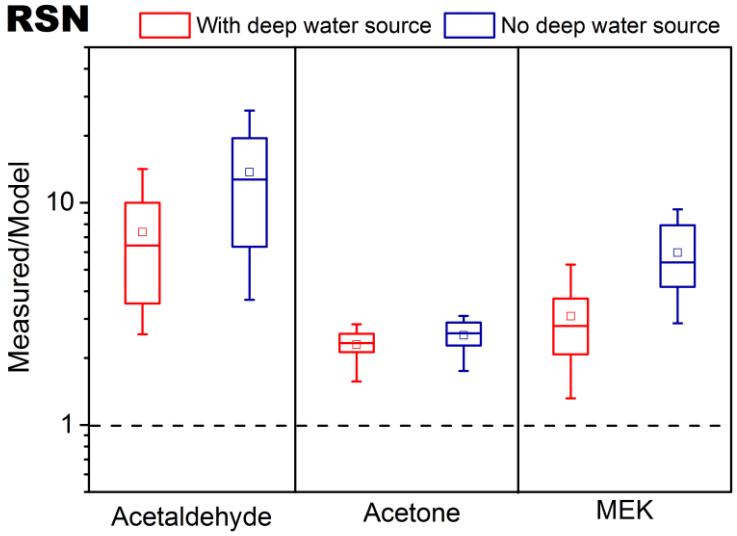

Figure S4. Comparison of model results for carbonyls with and without input of the ethane and propane deep water source in the North Red Sea.

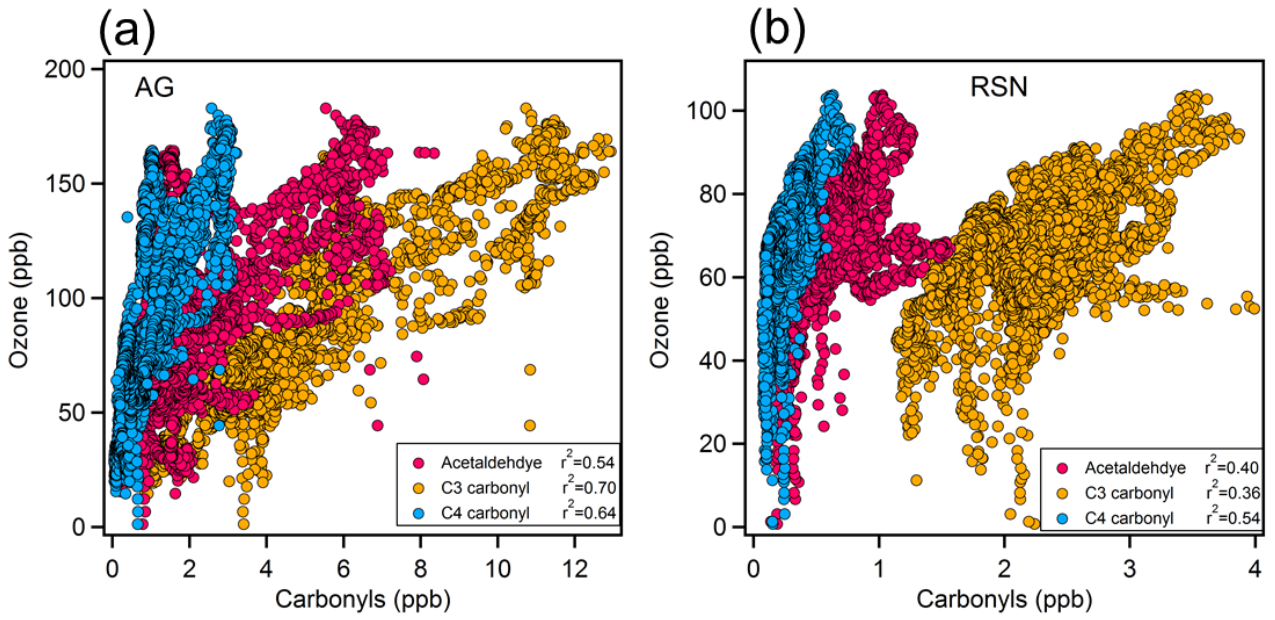

Figure S5. Scatter plots of carbonyls and ozone mixing ratios over the (a) Arabian Gulf (AG) and (b) Red Sea North (RSN).

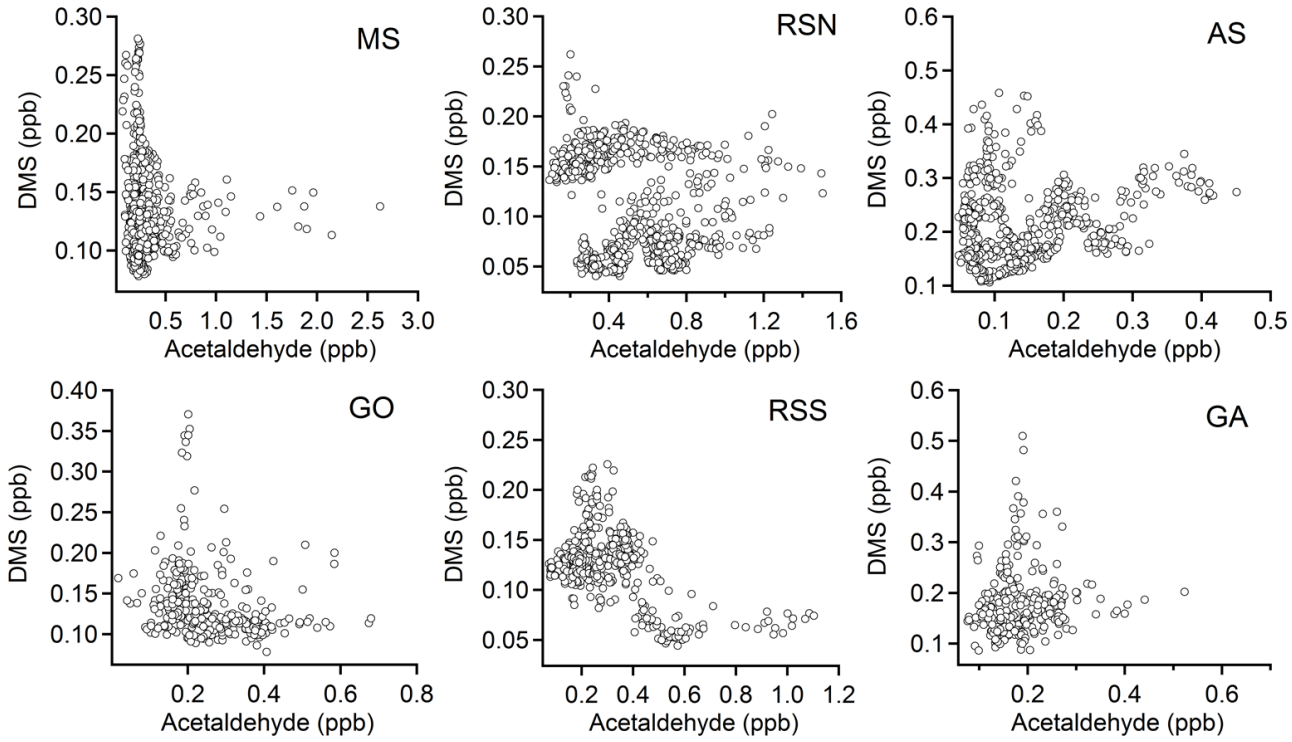

Figure S6. Scatter plots between dimethyl sulfide (DMS) and acetaldehyde mixing ratios over the eight regions.

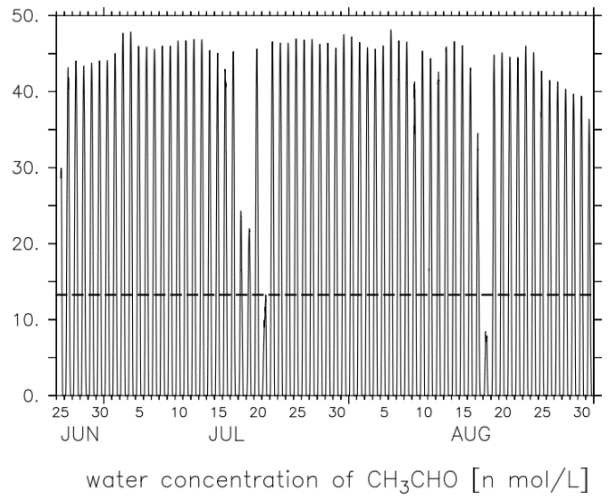

Figure S7. Estimated water concentration of acetaldehyde (nM) scaled according to solar radiation. The black dash line indicates the mean level 13.4 nM.

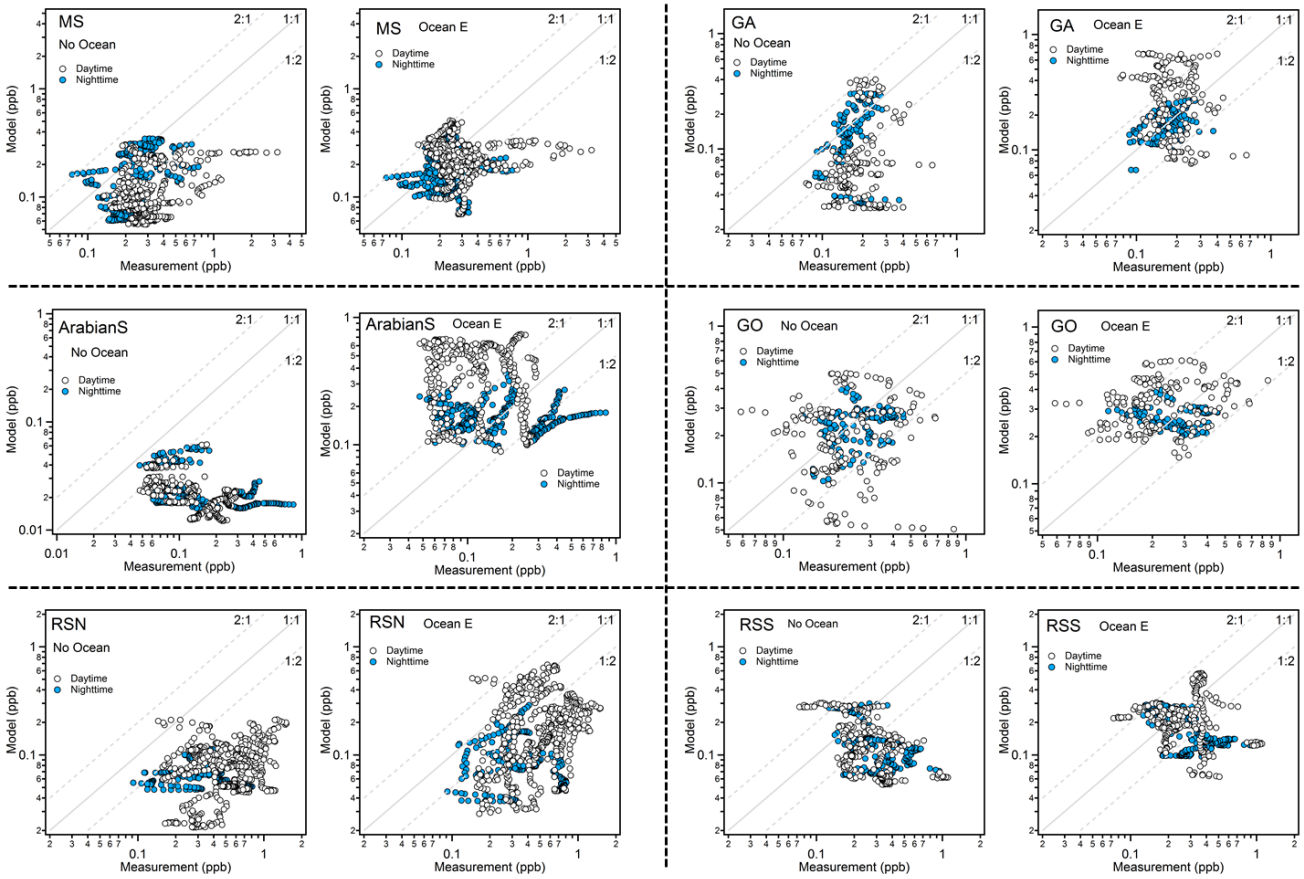

Figure S8. Scatter plots between measured and model simulated mixing ratios for acetaldehyde in different regions without ocean source (graph on the left side of each region labeled with No Ocean) and with ocean emission source (graph on the right side of each region labeled with Ocean E). The data points are further separated into day- and nighttime according to solar radiation.

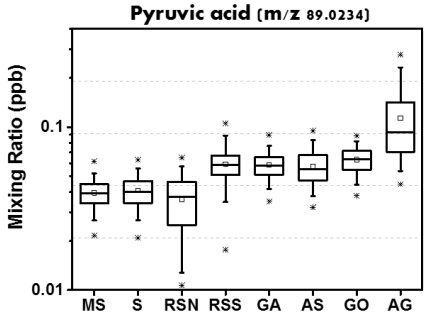

Figure S9. Spatial box plot statistics for pyruvic acid (m/z 89.0234) mixing ratios.

Table S1. Detection limit (LOD) and total uncertainty of standard gas calibrated trace gases during AQABA

Compounds	**Protonated Masses**	**LOD (mean ± σ) (ppt)**	**LOD Range (ppt)**	**Total Uncertainty (%)**
Methanol	33.0335	105 ± 40	31-302	17
Acetonitrile	42.0339	13 ± 3	4-23	6
Acetaldehyde	45.0335	52 ± 26	10-194	8
Acetone	59.0492	22 ± 9	6-122	6
DMS	63.0263	13 ±5	2-30	12
Isoprene	69.0699	15 ± 10	2-98	6
Methacrolein/ Methyl Vinyl Ketone	71.0492	7 ± 2	2-19	6
MEK	73.0648	9 ± 6	3-80	6
Benzene	79.0543	6 ± 2	2-16	7
Toluene	93.0699	4 ± 1	1-8	8
Xylene	107.0856	4 ± 1	1-10	7
1,3,5-Trimethylbenzene	121.1012	3 ± 1	1-13	7
α-pinene	137.1325	5 ± 3	2-38	7

Table S2. Protonated masses, chemical formula and limit of detection of carbonyl compounds.

Protonated Masses	**Chemical Formula**	**LOD Average (ppt)**	**LOD Range (ppt)**
Aliphatic CCs	**$C_nH_{2n}OH^+$**		
87.0805	$C_5H_{10}OH^+$	10	4-28
101.0961	$C_6H_{12}OH^+$	11	3-34
115.1118	$C_7H_{14}OH^+$	7	1-22
129.1274	$C_8H_{16}OH^+$	6	1-24
143.1431	$C_9H_{18}OH^+$	5	1-28
Unsaturated CCs	**$C_nH_{2n-2}OH^+$**		
85.0648	$C_5H_8OH^+$	12	3-34
99.0805	$C_6H_{10}OH^+$	12	3-39
113.0961	$C_7H_{12}OH^+$	6	1-19
127.1118	$C_8H_{14}OH^+$	5	1-9
141.1274	$C_9H_{16}OH^+$	4	1-12
Aromatic CCs	**$C_nH_{2n-8}OH^+$**		
107.0492	$C_7H_6OH^+$	10	3-31
121.0648	$C_8H_8OH^+$	7	2-21
135.0805	$C_9H_{10}OH^+$	12	2-45

Table S3. OH rate constant of hydrocarbons and carbonyls mentioned in the study

Formula	Compound	CAS	k (OH) cm^3 $molecule^{-1}s^{-1}$ at 298K
Alkanes			
CH4	methane*	74-82-8	6.40E-15
C2H6	ethane*	74-84-0	2.40E-13
C3H8	propane*	74-98-6	1.10E-12
C4H10	i-butane	75-28-5	2.12E-12
C4H10	n-butane*	106-97-8	2.35E-12
C5H12	i-pentane	78-78-4	3.60E-12
C5H12	n-pentane	109-66-0	3.80E-12
C6H14	i-hexane	107-83-5	5.20E-12
C6H14	n-hexane	110-54-3	5.20E-12
C7H16	n-heptane	142-82-5	6.76E-12
C8H18	octane	111-65-9	8.11E-12
Alkenes			
C2H4	ethene		8.52E-12
Aliphatic Carbonyls			
CH2O	formaldehyde*	50-00-0	8.50E-12
C2H4O	acetaldehyde*	75-07-0	1.50E-11
C3H6O	acetone*	67-64-1	1.80E-13
C4H8O	methyl ethyl ketone*	78-93-3	1.10E-12
C5H10O	2-pentanone	107-87-9	4.40E-12
	3-pentanone	96-22-0	2.00E-12
	3-methyl-2-butanone	563-80-4	2.90E-12
C6H12O	3,3-dimethyl-2-butanone	75-97-8	1.20E-12
	2-hexanone	591-78-6	9.10E-12
	3-hexanone	589-38-8	6.90E-12
	4-methyl-2-pentanone	108-10-1	1.30E-11
	3-methyl-2-pentanone	565-61-7	6.90E-12
C7H14O	2,4-dimethyl-3-pentanone	565-80-0	5.00E-12
	2-heptanone	110-43-0	1.10E-11
	5-methyl-2-hexanone	110-12-3	1.00E-11
C8H16O	2-octanone	111-13-7	1.10E-11

Compounds marked with * represent k(OH) taken from Atkinson et.al. (2006). Otherwise k (OH) were taken from Atkinson and Arey (2003).

Table S4. Production yields of aliphatic carbonyls from hydrocarbons.

	C1 HCHO	C2 CH3CHO	C3 Acetone	C4 MEK	C5	C6	C7	C8
methane	0.999	-	-	-	-	-	-	-
ethane	-[a]	0.991	-	-	-	-	-	-
propane	-	-	0.705	-	-	-	-	-
i-butane	0.773	-	0.774	-	-	-	-	-
n-butane	-	0.791	-	0.397	-	-	-	-
i-pentane	-	0.715	0.714	-	0.133	-	-	-
n-pentane	-	0.150	-	-	0.399	-	-	-
i-hexane	-	0.071	0.220	-	-	0.160	-	-
n-hexane	-	-	-	-	-	0.199	-	-
n-heptane	-	-	-	-	-	-	1.00[b]	-
octane	-	-	-	-	-	-	-	1.00[b]
ethene	1.60	-	-	-	-	-	-	-

Values are derived from Master Chemical Mechanism, MCM v3.2 via website: http://mcm.leeds.ac.uk/MCM (last accessed on Jan-15, 2020).
a: "-" refers no yield.
b: No information could be found for C7 and C8 hydrocarbon. Therefore the production yield of 1 is estimated for C7 and C8 aliphatic CCs from C7and C8 hydrocarbons.

References

Atkinson, R., and Arey, J.: Atmospheric Degradation of Volatile Organic Compounds, Chemical Reviews, 103, 4605-4638, 10.1021/cr0206420, 2003.

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