Supplementary Information

Chemical characteristics of cloud water and the impacts on aerosol properties at a subtropical mountain site in Hong Kong

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Table S1. Description of six cloud events at Mt. TMS in November 2015. Sampling time, sample number (n), liquid water content (LWC), pH values, equivalent molar ratios of chloride, potassium, calcium and magnesium to sodium and non-sea-salt sulfate (nss-SO_4^{2-}) to nitrate, formic-to-acetic acid (F/A) ratio in cloud water and in the corresponding gas phase (calculated), and trace gases are included.

Events	Day	Sampling duration	n	LWC (g m^{-3})	pH	Cl$^-$/Na$^+$ (1.16*)	K$^+$/Na$^+$ (0.02*)	Ca^{2+}/Na$^+$ (0.04*)	Mg^{2+}/Na$^+$ (0.23*)	nss-SO$_4^{2-}$/NO$_3^-$	F/A (cloud)	F/A (gas)	SO$_2$ (ppb)	NO$_x$ (ppb)	Air mass description
E.1	8	15:10-17:30	1	0.08	5.5	2.14	0.41	5.06	0.47	1.03	2.29	0.41	2.7	12.3	Heavily polluted by cold front, continental, altitude <1 km
E.2	9	03:10-15:00	4	0.18	3.82	3.11	0.50	4.15	0.48	1.38	1.59	1.18	1.3	1.9	Clean after cold front passage, continental, <1 km
E.3	11	12:20-21:40	2	0.21	3.3	2.46	0.15	0.58	0.23	0.91	1.24	1.48	1.1	1.6	Circling from sea to PRD region, mixed, <1 km
E.4	15-16	21:10-13:20	6	0.15	3.17	1.62	0.06	0.13	0.22	1.48	1.50	1.89	0.8	1.1	Along the southeast coast of China, mixed, <1 km
E.5	18-19	16:30-13:10	8	0.28	3.56	1.51	0.04	0.04	0.22	1.69	1.67	1.69	0.7	0.8	Deriving from west Pacific Ocean, marine, 1 to 1.5 km
E.6	21-22	12:30-16:00	11	0.35	4.19	1.50	0.04	0.08	0.16	1.51	0.90	0.50	0.9	1.6	Deriving from west Pacific Ocean, marine, > 1.5 km

*: equivalent molar ratio of seawater

Table S2. Concentration ratios of formaldehyde/acetaldehyde (C1/C2) and acetaldehyde/propanal (C2/C3) in the gas phase during cloud events. The gas phase carbonyl compounds in E.1 and E.2 were NOT measured.

Event	C1/C2	C2/C3
E.3	2.83±0.46	6.40±1.74
E.4	4.53±2.76	4.44±1.57
E.5	3.81±0.54	5.80±2.58
E.6	3.00±0.58	3.75±0.81

Table S3. Carbonyls concentrations (Mean ± SD) in cloud water and gas phase, as well as measured and theoretical partitioning fraction of carbonyls in the aqueous phase (F_p). The measured carbonyls in cloud water were scaled by LWC to their air equivalent concentrations.

	Cloud water (ppbv)	Gas phase (ppbv)	F_p Measured	F_p Theoretical	K_H M atm^{-1}	ref
Glyoxal	$(5.61 \pm 3.87) \times 10^{-2}$	0.05 ± 0.01	5.08×10^{-1}	7.48×10^{-1}	4.19×10^{5}	(Ip et al., 2009)
Methylglyoxal	$(1.22 \pm 1.03) \times 10^{-1}$	0.19 ± 0.14	3.14×10^{-1}	2.03×10^{-1}	3.2×10^{4}	(Zhou and Mopper, 1990)
Formaldehyde	$(6.48 \pm 4.42) \times 10^{-3}$	1.98 ± 0.34	3.59×10^{-3}	2.60×10^{-2}	3.24×10^{3}	(Sander, 2015)
Acetaldehyde	$(2.16 \pm 1.23) \times 10^{-3}$	0.62 ± 0.21	3.83×10^{-3}	1.09×10^{-4}	13.17	(Sander, 2015)
Acetone	$(2.38 \pm 2.10) \times 10^{-3}$	2.23 ± 1.32	2.01×10^{-3}	2.26×10^{-4}	27	(Sander, 2015)
Propanal	$(5.05 \pm 5.90) \times 10^{-3}$	0.14 ± 0.05	3.24×10^{-2}	9.49×10^{-5}	9.9	(Sander, 2015)
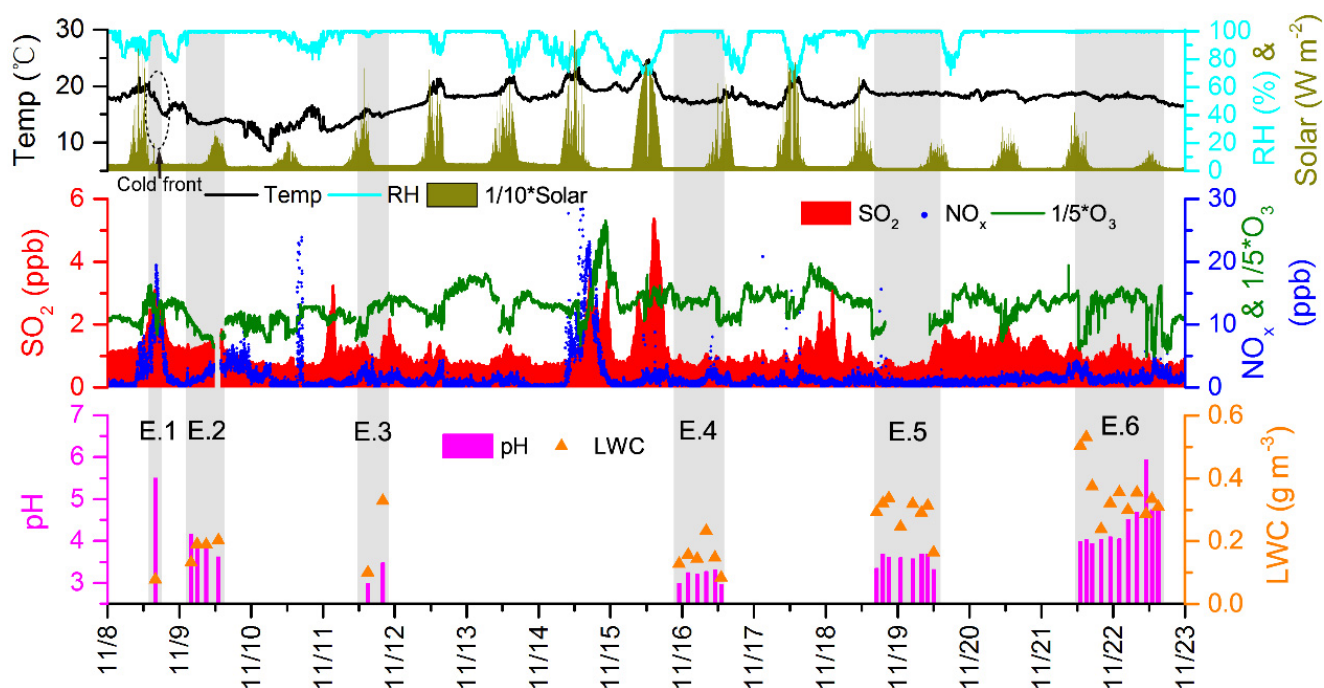
Figure S1. Time series of pH values and LWC of cloud water samples for six events (E.1-6) at Mt. TMS in Hong Kong in November 2016. Gray areas indicate cloud water sampling periods during the campaign. Meteorological parameters including temperature, relative humidity (RH) and solar radiation are shown in the top panel. Trace gases (SO_2, NO_x and O_3) are displayed in the middle panel. A short-time cold front passage (14:00-20:00, 8 November 2016) is labeled by dotted ellipse, which is recorded by Hong Kong observatory (www.weather.gov.hk/contente.htm).
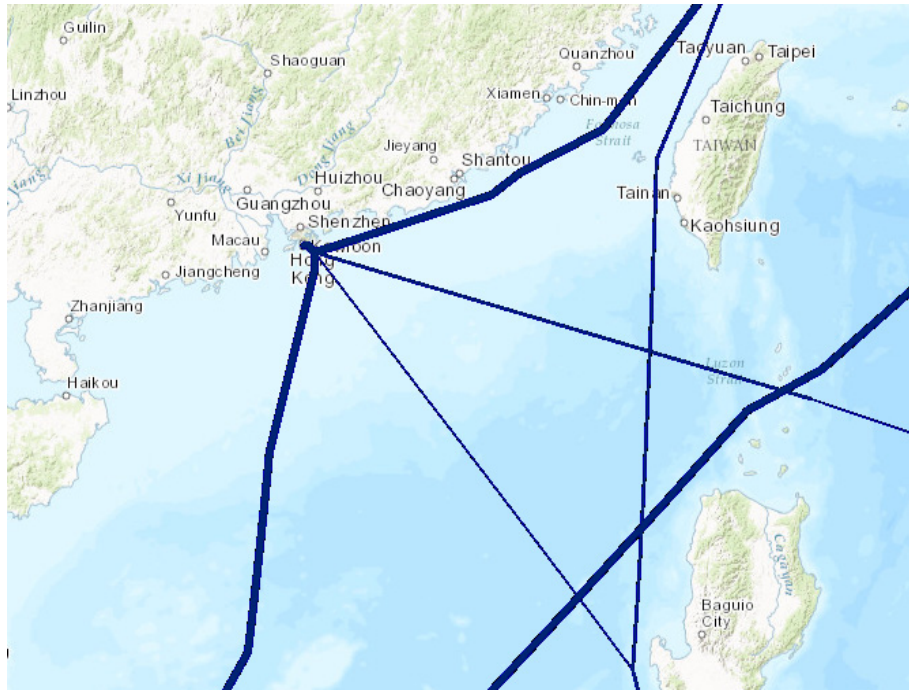
Figure S2. International shipping routes going throgh Hong Kong in the western Pacific Ocean.
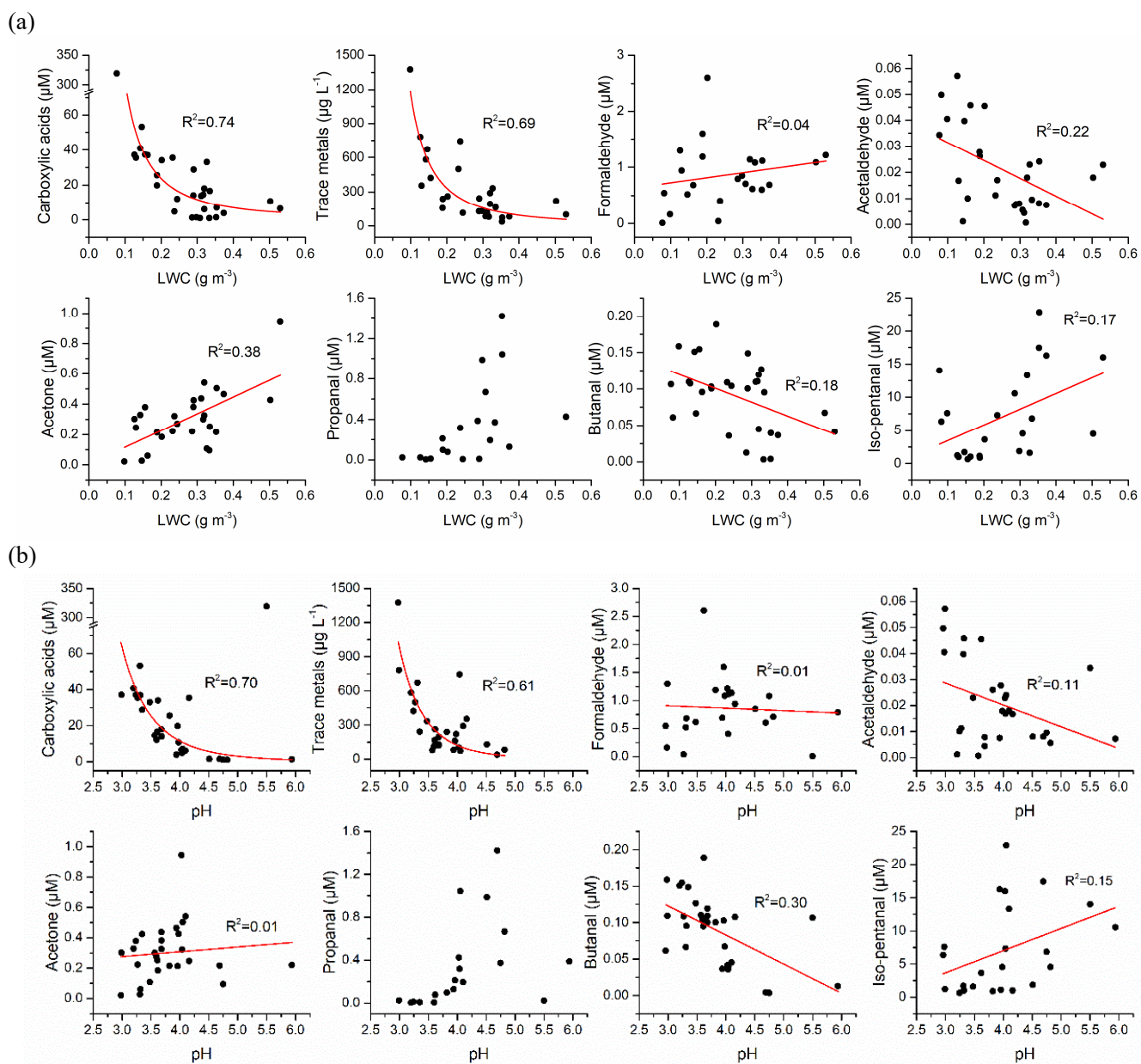
Figure S3. Relationships of carboxylic acids, trace metals and individual carbonyl compounds with (a) LWC and (b) pH in cloud water.
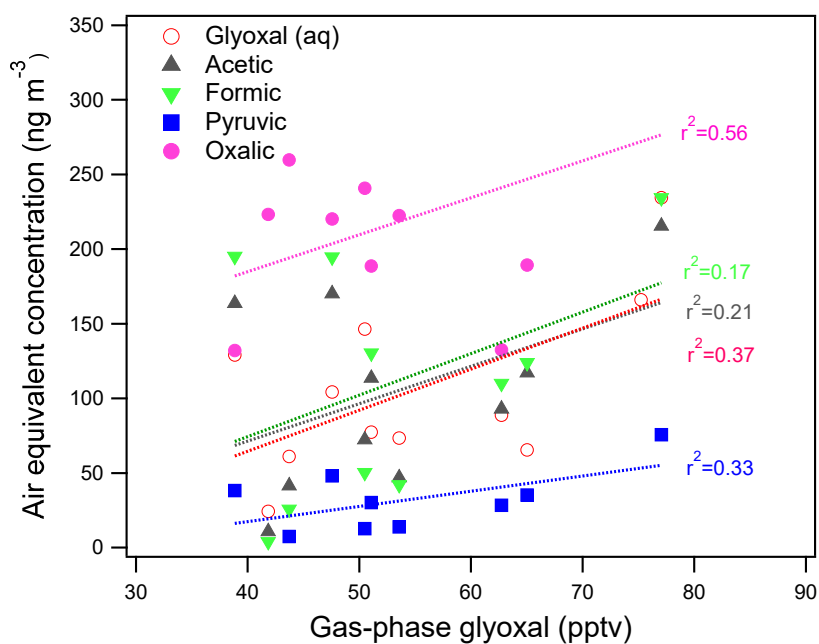
Figure S4. Relationships of the aqueous-phase glyoxal and carboxylic acids with gas-phase glyoxal. Air equivalent concentrations of aqueous phase organics were used to eliminate LWC effects.

References

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