Supplement of Atmos. Chem. Phys., 21, 3181–3192, 2021
https://doi.org/10.5194/acp-21-3181-2021-supplement

Atmospheric Chemistry and Physics
Open Access

Supplement of

Measurement report: Chemical characteristics of $PM_{2.5}$ during typical biomass burning season at an agricultural site of the North China Plain

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Table S1. Biomass burning tracer levels and ratios measured in this study and other published field studies.

Location	Site type	Condition	Size	K^+ (μg m^{-3})	Levoglucosan (μg m^{-3})	Mannosan (μg m^{-3})	Levoglucosan/ Mannosan	Levoglucosan/ K^+	Reference
Gucheng	Rural	Minor biomass burning	$PM_{2.5}$	1.16 ± 0.36	0.36 ± 0.14	0.015 ± 0.005	24.9 ± 4.44	0.36 ± 0.081	This study
	Rural	Intensive biomass burning	$PM_{2.5}$	2.61	4.37	0.18	24.1	1.67	This study
	Rural	Major biomass burning	$PM_{2.5}$	1.76 ± 0.46	0.90 ± 0.37	0.038 ± 0.015	24.8 ± 6.46	0.51 ± 0.16	This study
	Rural	Heating season	$PM_{2.5}$	1.65 ± 0.84	0.96 ± 0.63	0.050 ± 0.026	18.3 ± 4.27	0.53 ± 0.15	This study
	Rural	Oct-Nov	$PM_{2.5}$	1.52 ± 0.62	0.79 ± 0.75	0.030 ± 0.030	23.6 ± 0.59	0.46 ± 0.26	This study
Gucheng	Rural	June, 2013	$PM_{2.5}$	/	0.24 ± 0.29	0.10 ± 0.10	22.8 ± 8.85	/	Li et al., (2019)
	Rural	Biomass burning episode	$PM_{2.5}$	/	0.40 ± 0.34	0.015 ± 0.013	29.7 ± 12.2	/	Li et al., (2019)
Beijing, China	Urban	Typical summer	$PM_{2.5}$	0.84 ± 0.58	0.12 ± 0.05	0.01 ± 0.00	12.7 ± 3.38	0.26 ± 0.16	Cheng et al. (2013)
	Urban	Biomass burning episode	$PM_{2.5}$	5.81 ± 2.75	0.75 ± 0.68	0.03 ± 0.04	25.0 ± 13.2	0.11 ± 0.06	Cheng et al. (2013)
	Urban	Typical winter	$PM_{2.5}$	1.21 ± 0.08	0.64 ± 0.45	0.07 ± 0.05	0.51 ± 0.15	0.51 ± 0.15	Cheng et al. (2013)
	Urban	Fireworks episode	$PM_{2.5}$	6.03 ± 11.3	0.46 ± 0.29	0.04 ± 0.03	0.16 ± 0.09	0.16 ± 0.09	Cheng et al. (2013)
PRD, China	Urban	Annual	$PM_{2.5}$	/	0.059 ± 0.060	0.004 ± 0.005	/	/	Ho et al. (2014)
	Agricultural	Annual	$PM_{2.5}$	/	0.208 ± 0.162	0.014 ± 0.012	/	/	Ho et al. (2014)
	Rural	Annual	$PM_{2.5}$	/	0.036 ± 0.075	0.003 ± 0.006	/	/	Ho et al. (2014)
	Roadside	Annual	$PM_{2.5}$	/	0.026 ± 0.010	0.003 ± 0.005	/	/	Ho et al. (2014)
Guangzhou, China	Urban	Wet season	$PM_{2.5}$	0.465 ± 0.302	0.073 ± 0.081	0.006 ± 0.007	11.5	0.29	Zhang et al. (2015)
	Urban	Dry season	$PM_{2.5}$	1.197 ± 0.356	0.27 ± 0.10	0.017 ± 0.007	15.3	0.40	Zhang et al. (2015)
Zhuhai, China	Suburban	Wet season	$PM_{2.5}$	0.17 ± 0.10	0.008 ± 0.009	L.D.	N.A.	N.A.	Zhang et al. (2015)
	Suburban	Dry season	$PM_{2.5}$	0.844 ± 0.325	0.181 ± 0.124	0.010 ± 0.06	18.5	0.42	Zhang et al. (2015)
Southeastern China	Urban	Nov-July	$PM_{2.5}$	/	0.059 ± 0.047	/			Wu et al. (2016)
Xi'an, China	Urban	Winter	$PM_{0.133}$		0.29 ± 0.14	0.17 ± 0.10	2.83	0.32 ± 0.14	Zhu et al. (2017)

	Rural	Winter	$PM_{0.133}$		0.93 ± 0.32	0.16 ± 0.26	7.86	0.77 ± 0.39	Zhu et al. (2017)
Nanjing, China	Urban	January	$PM_{2.5}$	1.2 ± 0.7	0.37 ± 0.27	0.019 ± 0.013	22.5 ± 12.3	0.3 ± 0.1	Liu et al. (2019)
Shanghai, China	Urban	Nov-Dec (Episode)	$PM_{2.5}$	/	0.089 ± 0.040	0.003±0.001	29.7	/	He et al. (2020)
		Nov-Dec (Nonepisode)	$PM_{2.5}$	/	0.033±0.030	0.001±0.001	33	/	He et al. (2020)
Indo-Gangetic Plain	Mountain	All year	TSP	/	0.734 ± 1.043	/			Wan et al. (2017)
Shanghai, China	Urban	December	$PM_{2.5}$	/	0.046 ± 0.039	0.002 ± 0.002	/	/	Wang et al. (2020)
Mt. Tai, China	Mountain	Major biomass burning	TSP	5.9 ± 5.4	0.505 ± 0.578	/	/	/	Boreddy et al. (2017)
	Mountain	Minor biomass burning	TSP	1.9 ± 1.4	0.097 ± 0.183	/	/	/	Boreddy et al. (2017)
Lin'an	Background	Annual	$PM_{2.5}$	0.65 ± 0.38	0.13 ± 0.14	0.009 ± 0.01	13.2 ± 5.00	0.20 ± 0.16	Liang et al., (2020)
Budapest, Hungary	Urban	Winter	$PM_{2.5}$	/	0.387 ± 0.153	28 ± 14	14.6 ± 2.4	/	Salma et al. (2017)
Granada, Spain	Urban	Nov-Feb	PM_{10}	/	0.25	/	/	0.476	Titos et al. (2017)
Chiang Mai, Thailand	Urban	Non-episodic periods	PM_{10}	0.89 ± 0.57	0.333 ± 0.174	0.058 ± 0.020	5.7	0.37	Tsai et al. (2013)
	Urban	Episodic pollution	PM_{10}	2.31 ± 0.56	1.176 ± 0.791	0.083 ± 0.021	14.1	0.50	Tsai et al. (2013)
Daejeon, Korea	Suburban	Haze episode	$PM_{2.5}$	0.27 ± 0.08	0.022 ± 0.012	0.005 ± 0.002	4.81 ± 0.41	0.08 ± 0.03	Jung et al. (2016)
	Suburban	Siberian forest fire	$PM_{2.5}$	0.33 ± 0.07	0.120 ± 0.006	0.035 ± 0.003	3.43 ± 0.11	0.37 ± 0.06	Jung et al. (2016)
Kathmandu Valley, Nepal	Suburban	April, 2015	$PM_{2.5}$	0.63 ± 0.30	1.23 ± 1.15	/	/	1.95	Islam et al. (2020)
Kathmandu Valley, Nepal	Urban	2013-2014	TSP	2.43 ± 2.82	0.79 ± 0.69	0.051 ± 0.045	/	/	Wan et al. (2019)
Ulaanbaatar, Mongolia	Urban	Spring	$PM_{2.5}$	0.08 ± 0.05	0.31 ± 0.18	0.08 ±0.04	4.1 ± 1.0	4.2 ± 2.1	Nirmalkar et al. (2020)
		Winter	$PM_{2.5}$	0.13 ± 0.04	1.20 ± 0.43	0.33 ± 0.13	3.6 ± 0.2	8.9 ± 1.8	Nirmalkar et al. (2020)
Morogoro, Africa	Rural	Wet (May-Jun)	$PM_{2.5}$	0.382 ± 0.170	0.146 ± 0.085	0.013 ± 0.007	11 ± 0.8	0.37 ± 0.1	Mkoma et al. (2013)
	Rural	Dry (Jul-Aug)	$PM_{2.5}$	1.516 ± 0.73	0.253 ± 0.077	0.024 ± 0.007	11 ± 1.1	0.18 ± 0.7	Mkoma et al. (2013)
Krynica Zdroj, Poland	Rural	Annual	PM_{10}		0.51 ± 0.57			/	Klejnowski et al. (2017)
Northern Italy	Urban	Nov	$PM_{2.5}$	/	0.289 ± 0.144	0.064 ± 0.038	4.9 ± 0.8	/	Pietrogrande et al. (2015)
	Rural	Nov	$PM_{2.5}$	/	0.233 ± 0.115	0.047 ± 0.026	5.1 ± 0.5	/	Pietrogrande et al. (2015)

Figure S1. Location of the Gucheng measurement station (red star) and the surrounding provinces.

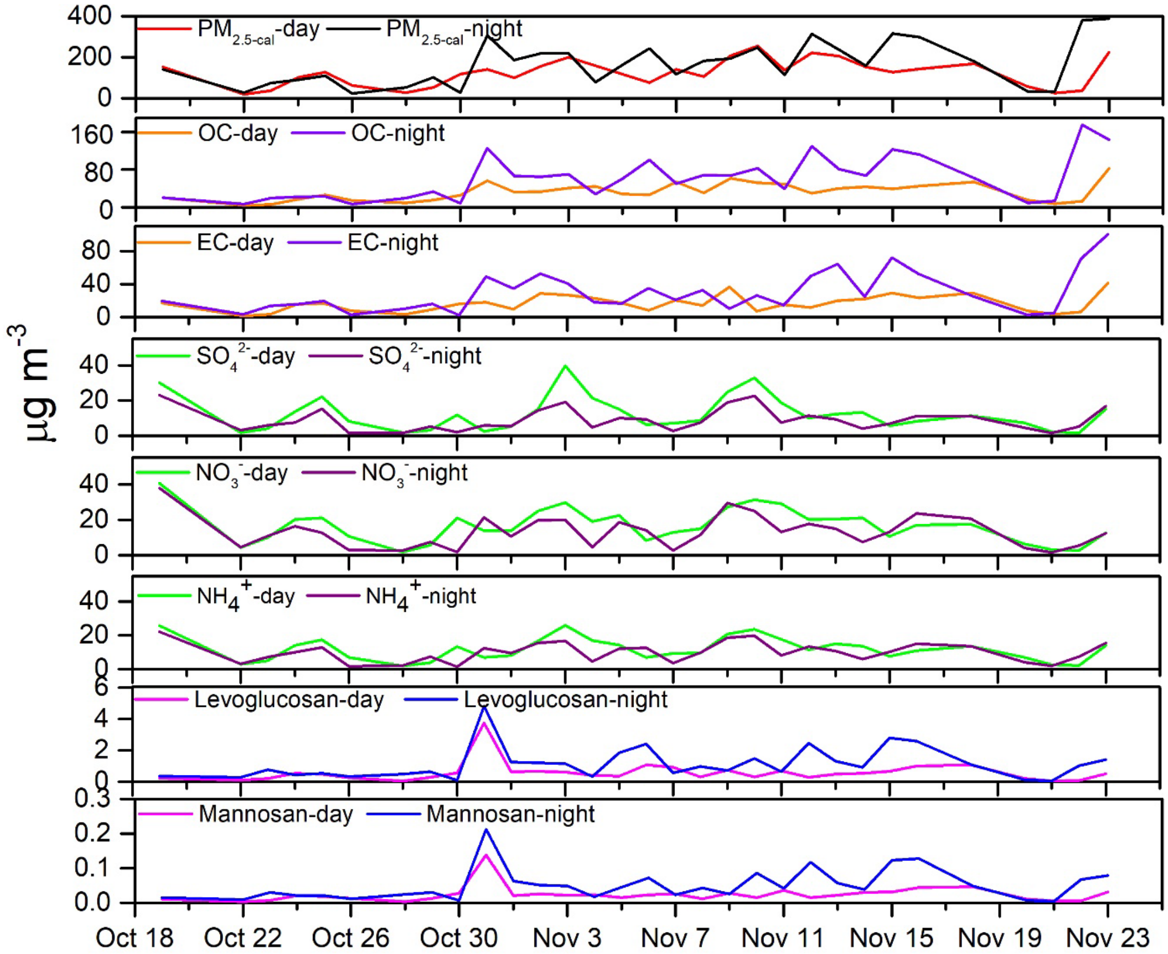

Figure S2. Time-series obtained for $PM_{2.5\text{-cal}}$ and its major components (OC, EC, SO_4^{2-}, NO_3^- and NH_4^+), biomass burning tracers (levoglucosan and mannosan) during daytime and nighttime at the GC site during the sampling period from 19 October to 23 November, 2016.

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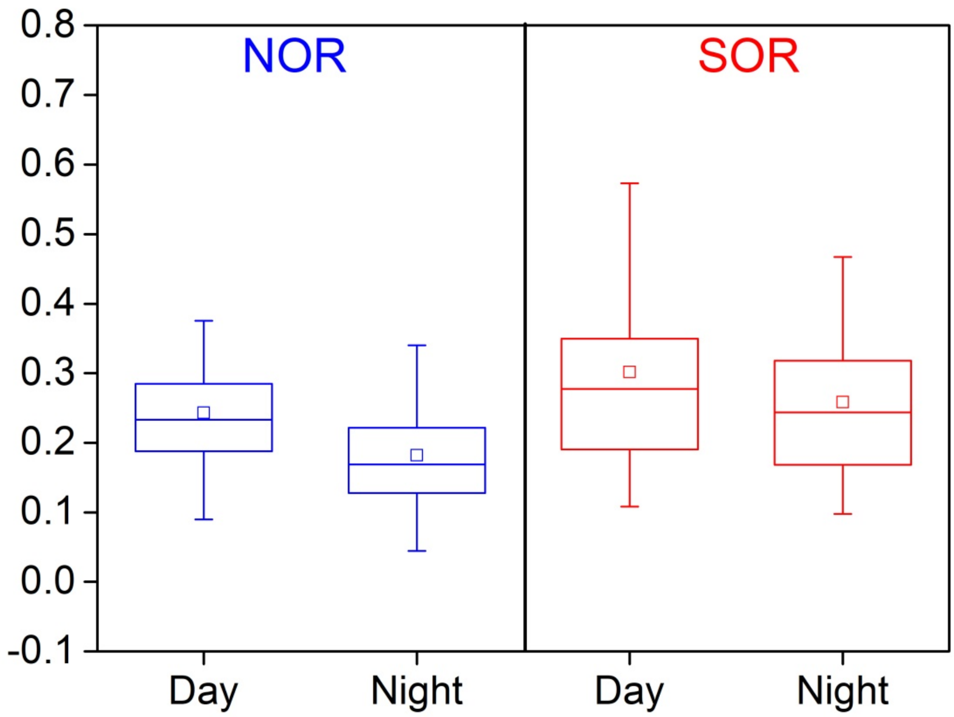

Figure S3. Variation of NOR and SOR during daytime and nighttime, respectively. In the box-whisker plots, the boxes and whiskers indicate the 95th, 75th, 50th (median), 25th and 5th percentiles, respectively. □ indicates the mean value.

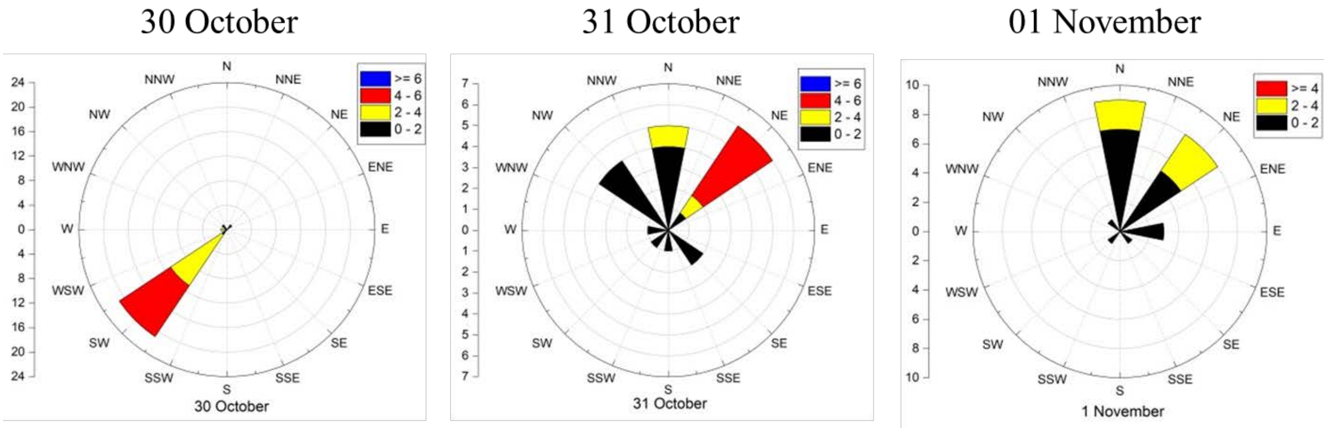

Figure S4. Wind-rose diagrams of hourly wind direction at the GC site during 30 October, 31 October and 1 November 2016, respectively.

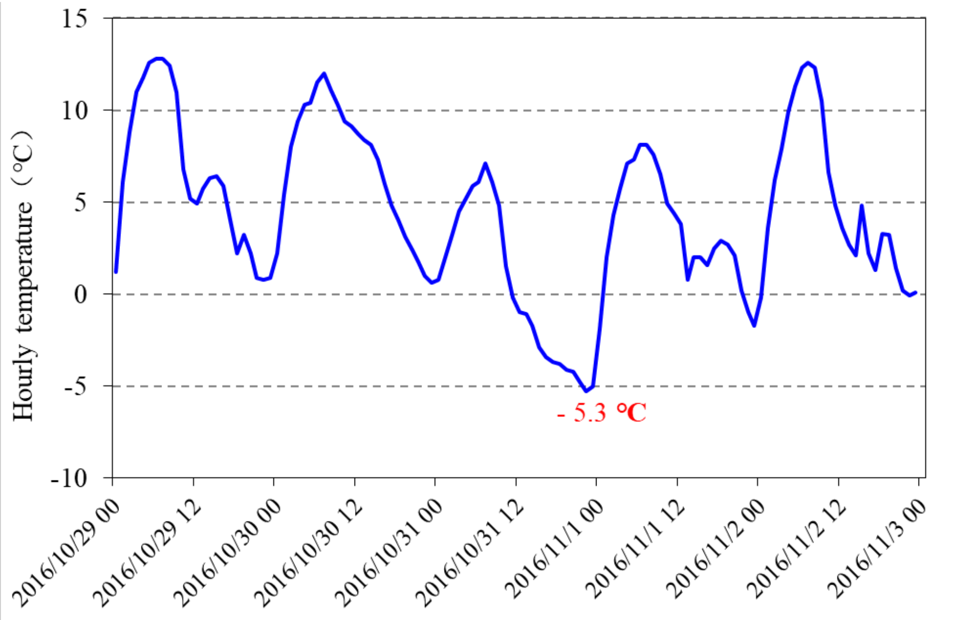

Figure S5. Hourly temperature from 00:00 on 29th October to 00:00 on 3rd November 2016 at the GC site.

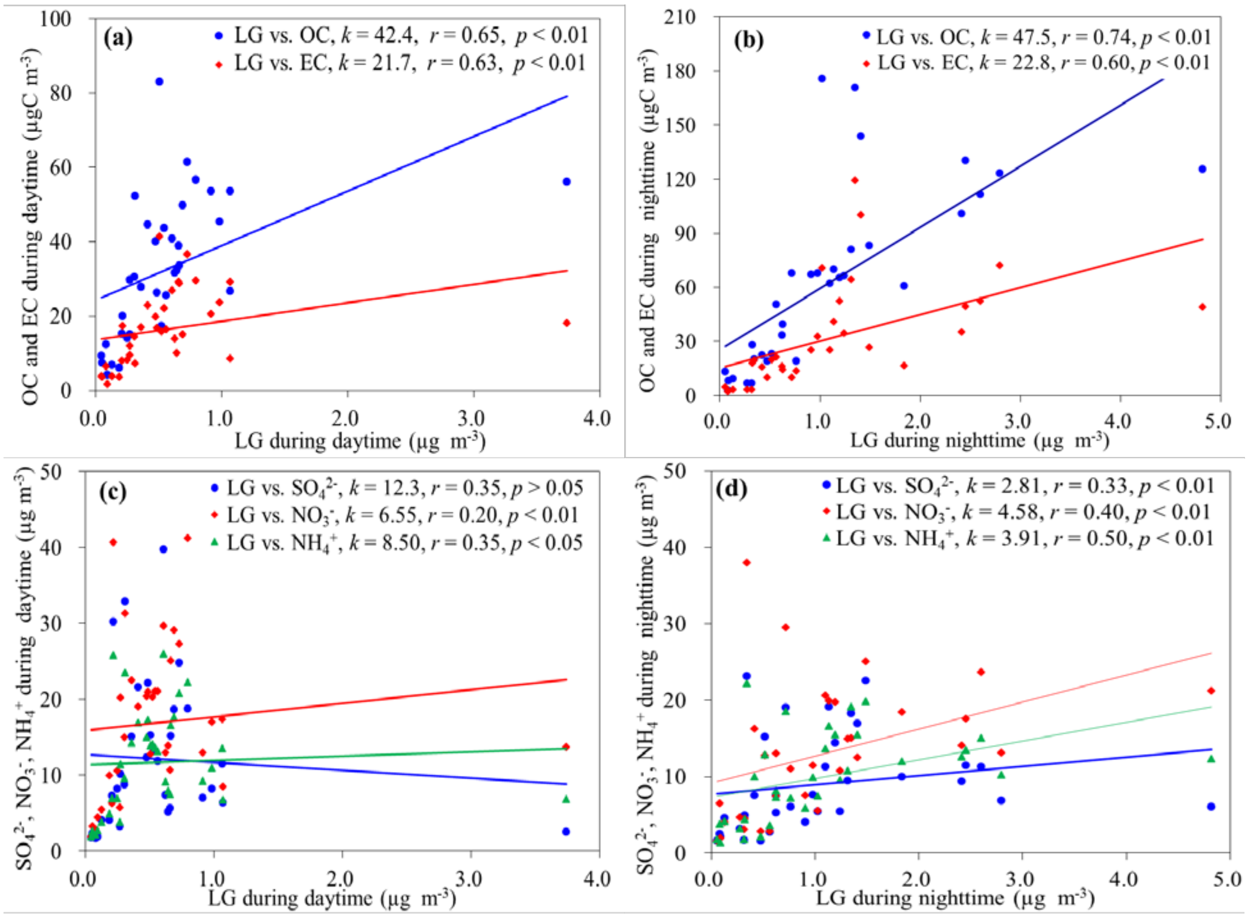

***Figure S6*. Correlations between levoglucosan (LG) and OC as well as EC during (a) daytime and (b) nighttime, and scatter plot of levoglucosan versus SNA (i.e., SO_4^{2-}, NO_3^- and NH_4^+) during (c) daytime and (d) nighttime. Statistical analysis was conducted with the linear fitting method.

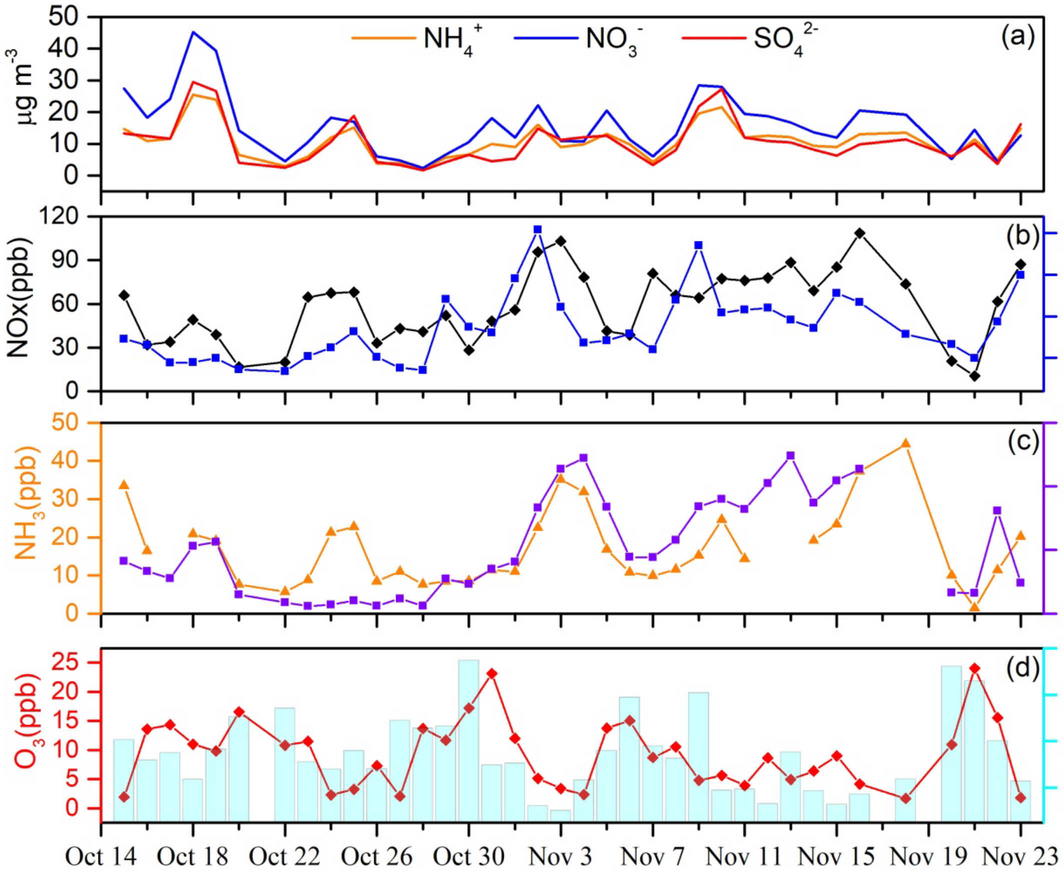

Figure S7**.** Time-series of (a) secondary inorganic aerosols, i.e., SO_4^{2-}, NO_3^- and NH_4^+, (b) SO_2 and NO_X, (c) NH_3 and CO, (d) O_3 and PBL, at the GC site during the observation period from 15 October to 23 November, 2016.

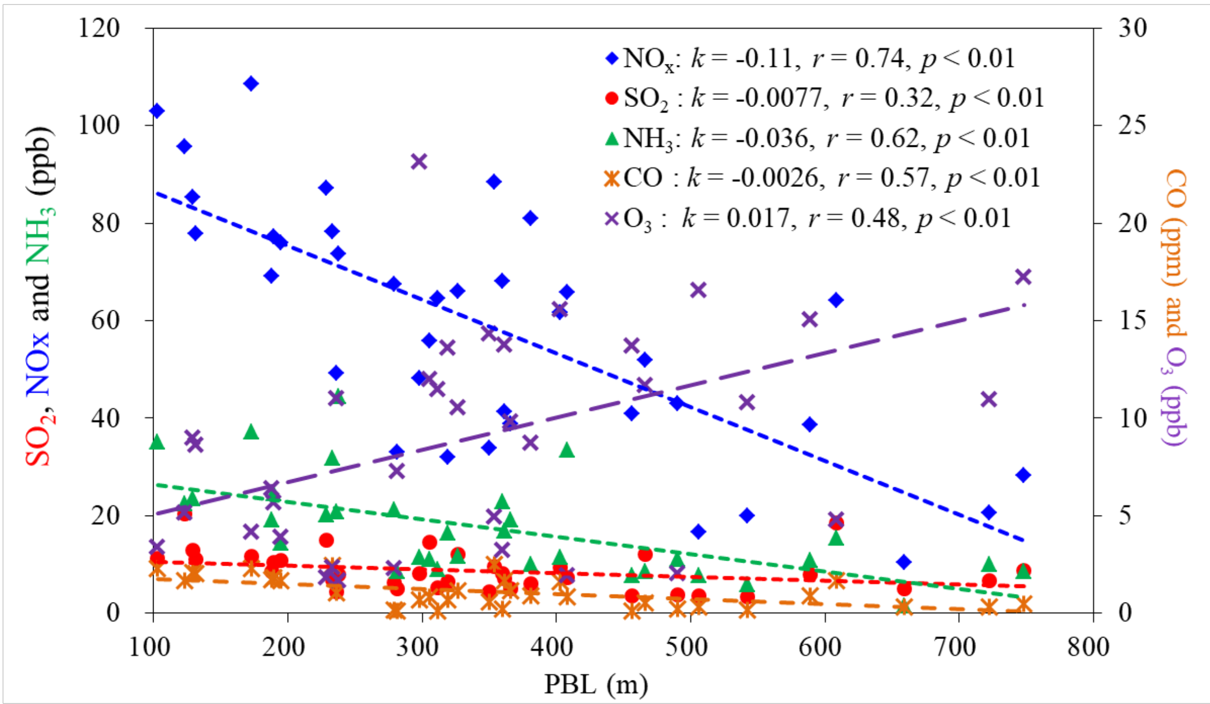

***Figure S8*.** Relationships between daily average PBL and gases at the GC site during the observation period. Statistical analysis was conducted with the linear fitting method.

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