1 *Supporting Information for*

2 **Aircraft-based observation of volatile organic compounds**

3 **(VOCs) over the North China Plain**

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13   **Table S1.** The list of VOC species calibrated with standard gas.

VOC species	Ion formula
Methanol	CH_4OH^+
Acetonitrile	$C_2H_3NH^+$
Acetaldehyde	$C_2H_4OH^+$
Ethanol	$C_2H_6OH^+$
Acetone	$C_3H_6OH^+$
Isoprene	$C_5H_8H^+$
MVK&MACR*	$C_4H_6OH^+$
MEK	$C_4H_8OH^+$
Benzene	$C_6H_6H^+$
Toluene	$C_7H_8H^+$
Styrene	$C_8H_8H^+$
C8 acromatics	$C_8H_{10}H^+$
C9 aromatics	$C_9H_{12}H^+$
C10 aromatics	$C_{10}H_{14}H^+$
Monoterpenes	$C_{10}H_{16}H^+$

15   * Methyl vinyl ketone (MVK) and methacrolein (MACR) were measured as their sum

16   by PTR-ToF-MS

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18   **Table S2.** The heights of the planetary boundary layer (HPBL) of Beijing determined

19   by the air parcel method during all the aerial surveys in Sep. 2017 and Jul. 2019.

Date and time	Aerial survey stage	HPBL (m)
2017/09/09 12:06-16:54	Ascending stage	1100
	Descending stage	1200
2017/09/12 12:16-16:10	Ascending stage	900
	Descending stage	1600
2017/09/13 13:35-16:55	Ascending stage	1000
	Descending stage	1400
2017/09/14 12:31-16:58	Ascending stage	850
	Descending stage	1300
2017/09/15 10:36-13:05	Ascending stage	450
	Descending stage	750
2019/07/14 9:41-12:18	Ascending stage	750
	Descending stage	1700

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21 **Table S3**. The means and standard deviations of VOC concentrations during all aerial surveys in Sep. 2017 in ppb.

Species	Sep. 9, 2017	Sep. 12, 2017	Sep. 13, 2017	Sep. 14, 2017	Sep. 15, 2017
Methanol	7.51±6.74	4.29±2.35	10.86±9.92	10.42±9.51	9.92±10.17
Acetonitrile	0.26±0.14	0.30±0.06	0.43±0.16	0.38 ±0.17	0.35±0.13
Acetaldehyde	3.11±1.92	2.35±1.91	3.44±3.11	3.34±3.21	2.32±2.39
Ethanol	10.81±14.23	6.29±8.29	17.09±21.56	23.03±36.10	14.47±22.72
Acetone	4.01±2.16	3.23±1.12	5.70±3.98	4.99 ±3.15	4.23±1.87
Isoprene	0.92±0.96	1.63±0.93	2.22±1.29	2.03±1.46	4.25±0.51
MVK&MACR*	0.60±0.73	3.65±1.13	3.65±1.65	2.64±1.22	1.79±0.72
MEK [c]	0.57±0.59	0.70±0.18	1.08±0.91	1.16±0.91	0.83±0.74
Benzene	0.46±0.38	0.20±0.37	0.61±0.66	0.49±0.52	0.43±0.41
Toluene	0.37±0.34	0.44±0.27	0.65±0.64	0.8 ±0.91	0.60±0.89
Styrene	0.28±0.20	0.09±0.13	0.07±0.08	0.08±0.09	0.06±0.08
C8 aromatics	0.62±0.55	0.63±0.37	1.20±2.33	1.24±1.96	1.13±1.95
C9 aromatics	0.34±0.19	0.55±0.20	0.59±0.33	0.48±0.42	0.41±0.34
C10 aromatics	0.3±0.22	0.34±0.14	0.29±0.15	0.25±0.15	0.22±0.14

Monoterpenes	0.19±0.17	1.34±0.23	0.95±0.24	0.71±0.21	0.59±0.18
Total VOCs	30.38±27.41	25.87±13.41	48.83±45.32	52.10±57.67	41.18±41.44

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23   * Methyl vinyl ketone (MVK) and methacrolein (MACR) were measured as their sum by PTR-ToF-MS.

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25   **Table S4**. The means and standard deviations of VOC concentrations below the planetary boundary layer (PBL) during all aerial surveys in Sep.

26   2017 in ppb.

Species	Sep. 9, 2017	Sep. 12, 2017	Sep. 13, 2017	Sep. 14, 2017	Sep. 15, 2017	AVG±SD
Methanol	17.56±1.77	9.43±2.07	27.00±3.08	21.23±10.50	29.65±4.73	21.94±8.30
Acetonitrile	0.43±0.06	0.34±0.06	0.68±0.09	0.55±0.22	0.58±0.10	0.53±0.16
Acetaldehyde	5.28 ±0.66	5.26±4.35	8.79±1.56	6.69±4.42	6.91±1.34	6.66±2.86
Ethanol	32.82±7.98	22.84±7.76	54.34±8.33	62.52±51.91	59.07±14.46	46.74±26.38
Acetone	7.51±0.51	3.85±1.19	11.47±0.62	8.39±3.44	7.52±1.02	8.10±2.72
Isoprene	2.63 ±0.99	2.99±1.69	4.19±0.93	3.69±1.77	4.49±0.74	3.60±1.40
MVK&MACR*	1.94±0.48	6.03±2.11	6.59±1.22	4.03±1.28	3.07±0.67	4.10±2.18
MEK	1.58±0.36	1.11±0.22	2.63±0.41	2.21±0.99	2.29±0.34	2.02±0.72
Benzene	1.08±0.28	0.56±1.30	1.74±0.65	1.07±0.65	1.20±0.27	1.19±0.73
Toluene	0.93±0.17	0.94±0.63	1.81±0.28	1.88±1.13	2.37±0.47	1.59±0.80
Styrene	0.17±0.07	0.26±0.44	0.19±0.12	0.17±0.11	0.16±0.12	0.18±0.19
C8 aromatics	1.66±0.59	1.51±0.47	4.39±4.43	3.20±3.04	4.71±1.97	3.18±2.95
C9 aromatics	0.64±0.15	0.88±0.52	1.16±0.36	0.88±0.64	1.03±0.32	0.91±0.44

C10 aromatics	0.65±0.21	0.56±0.38	0.49±0.26	0.38±0.22	0.40±0.20	0.51±0.27
Monoterpenes	0.42±0.19	1.46±0.38	1.18±0.29	0.84±0.24	0.61±0.22	0.84±0.45

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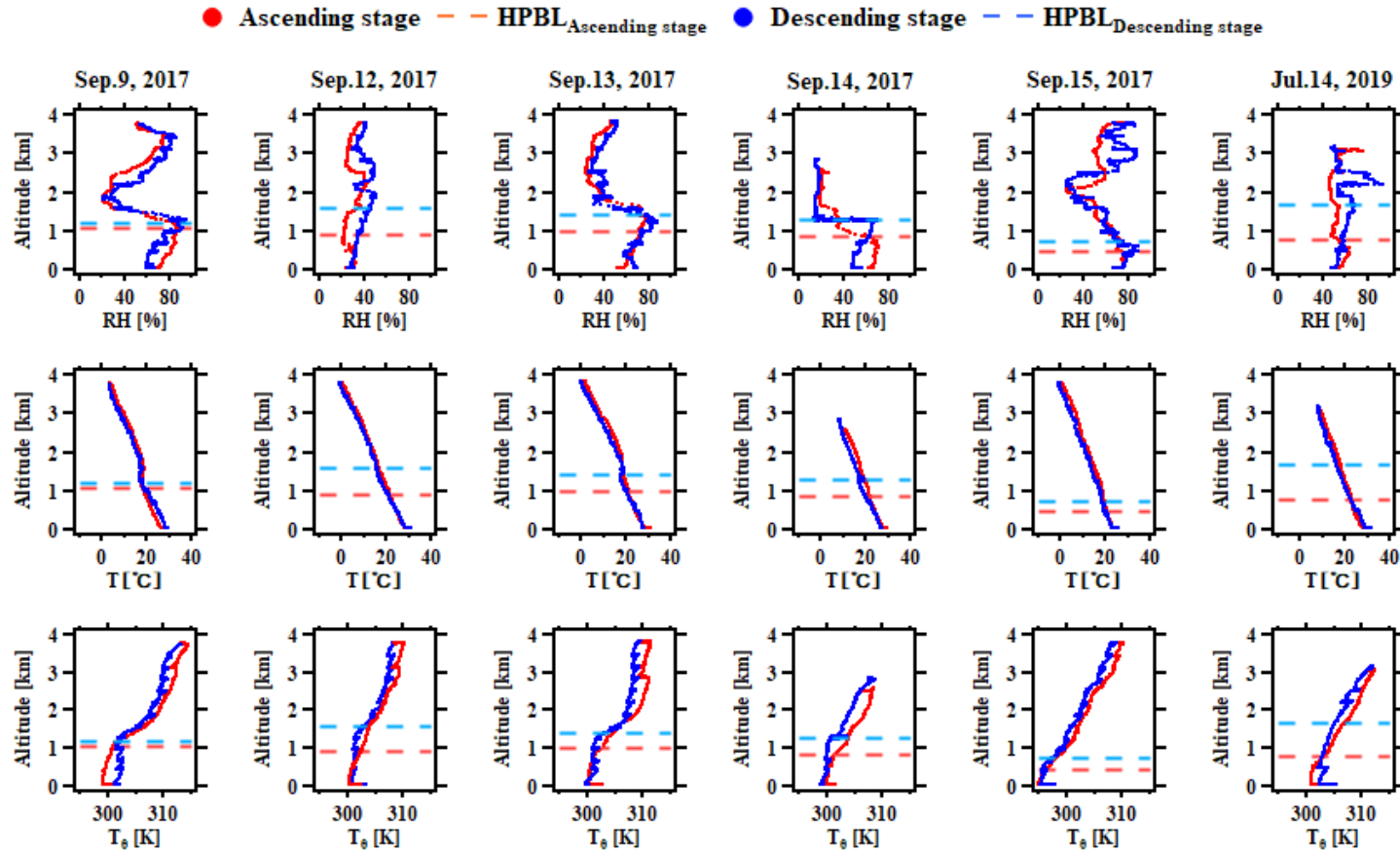
28   * Methyl vinyl ketone (MVK) and methacrolein (MACR) were measured as their sum by PTR-ToF-MS.

29

30 **Figure S1**. Vertical profiles of meteorological factors during Sep. 2017 and Jul. 2019 aerial surveys. The red and blue dots are the data measured

31 during the ascending and descending stages, respectively. The red and blue dashed lines show the HPBL during the ascending and descending

32 stages, respectively.

33

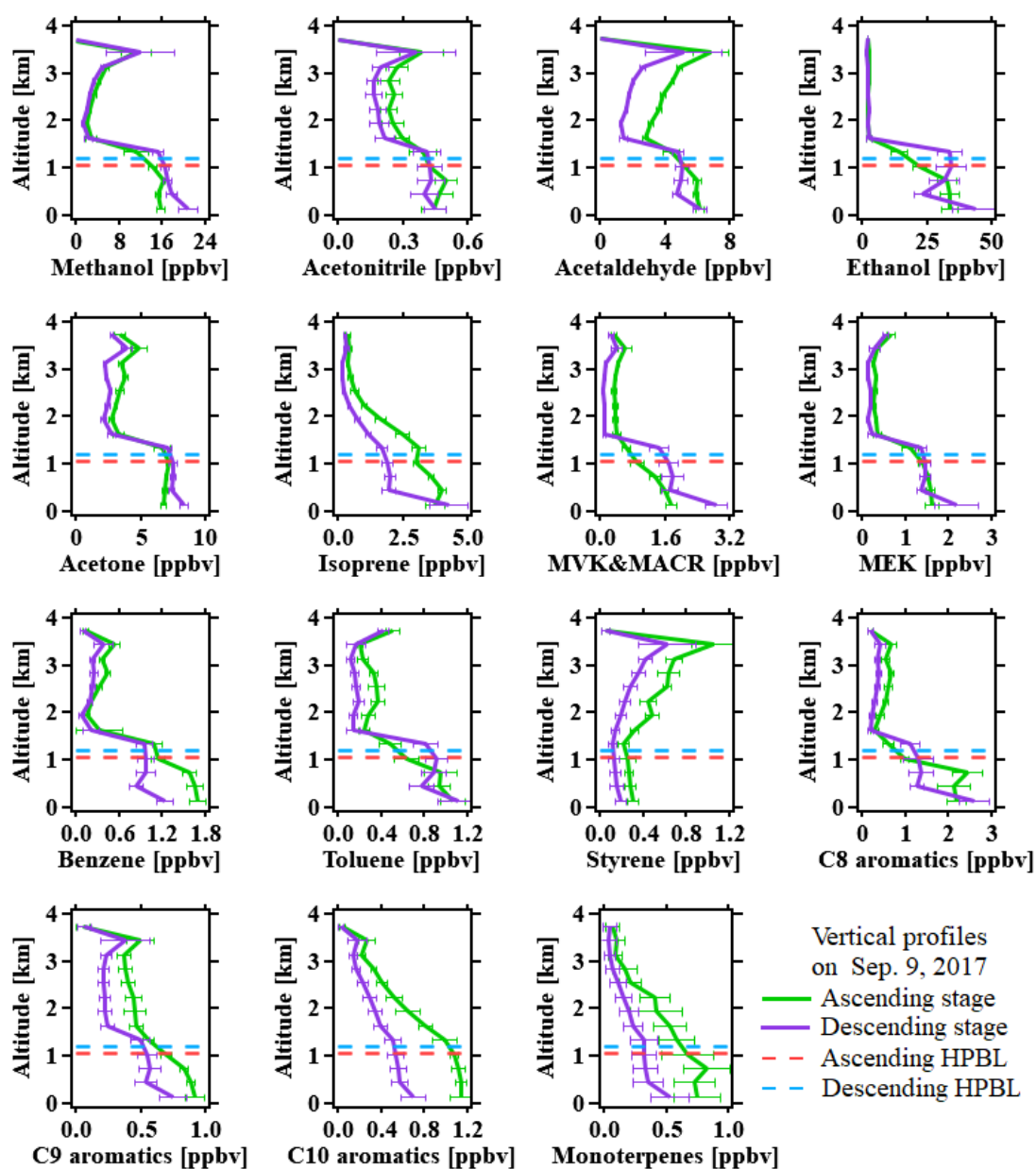
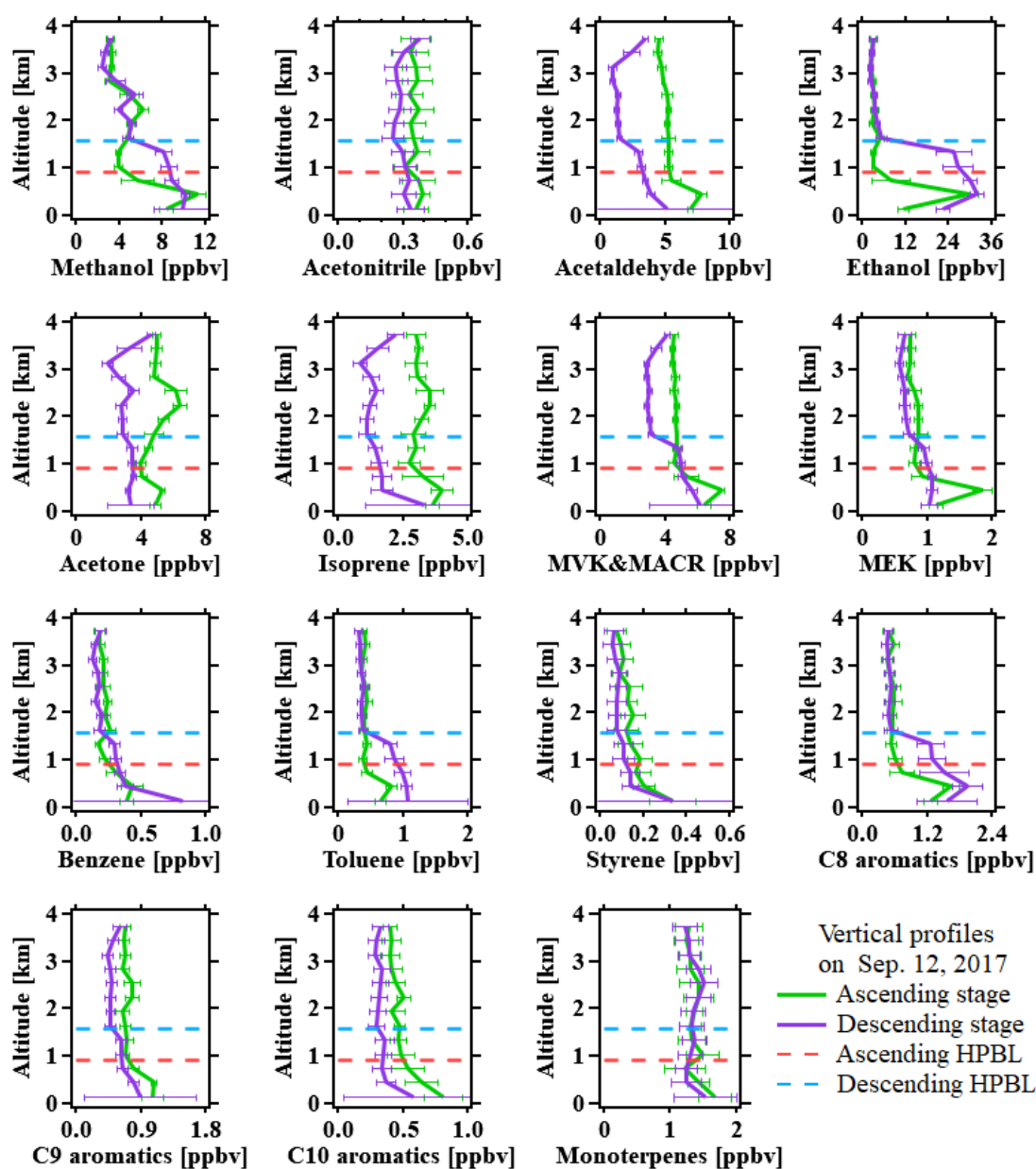



Figure S2. Vertical profiles of VOC mixing ratios during the ascending (in green) and
descending stages (in purple) for the aerial survey on Sep.9th, 2017, with error bars. The
red and blue dashed lines show the HPBL during the ascending and descending stages,
respectively.

38

39 **Figure S3.** Vertical profiles of VOC mixing ratios during the ascending (in green) and

40 descending stages (in purple) for the aerial survey on Sep.12th, 2017, with error bars.

41 The red and blue dashed lines show the HPBL during the ascending and descending

42 stages, respectively.

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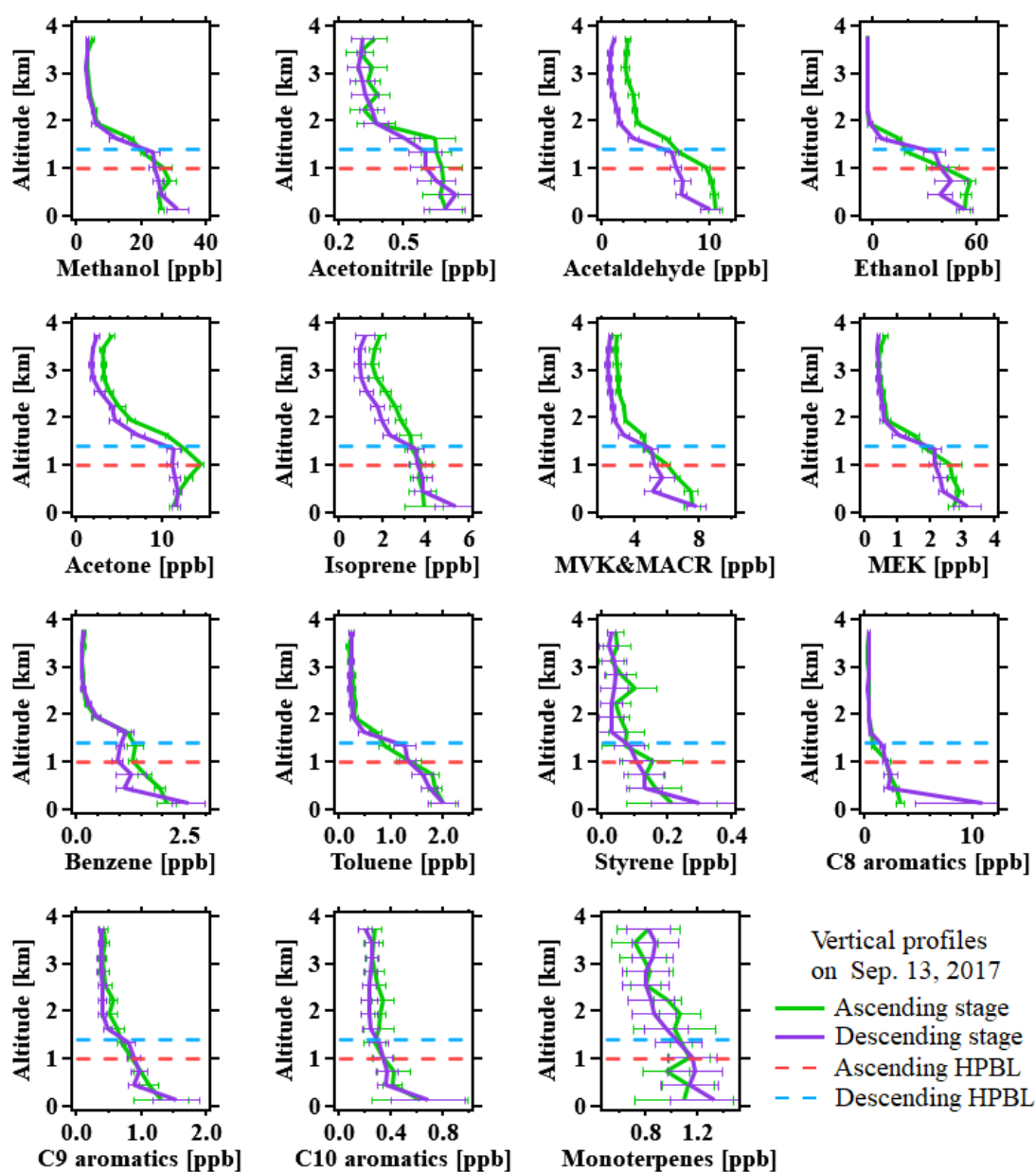
Figure S4. Vertical profiles of VOC mixing ratios during the ascending (in green) and descending stages (in purple) for the aerial survey on Sep.13th, 2017, with error bars. The red and blue dashed lines show the HPBL during the ascending and descending stages, respectively.

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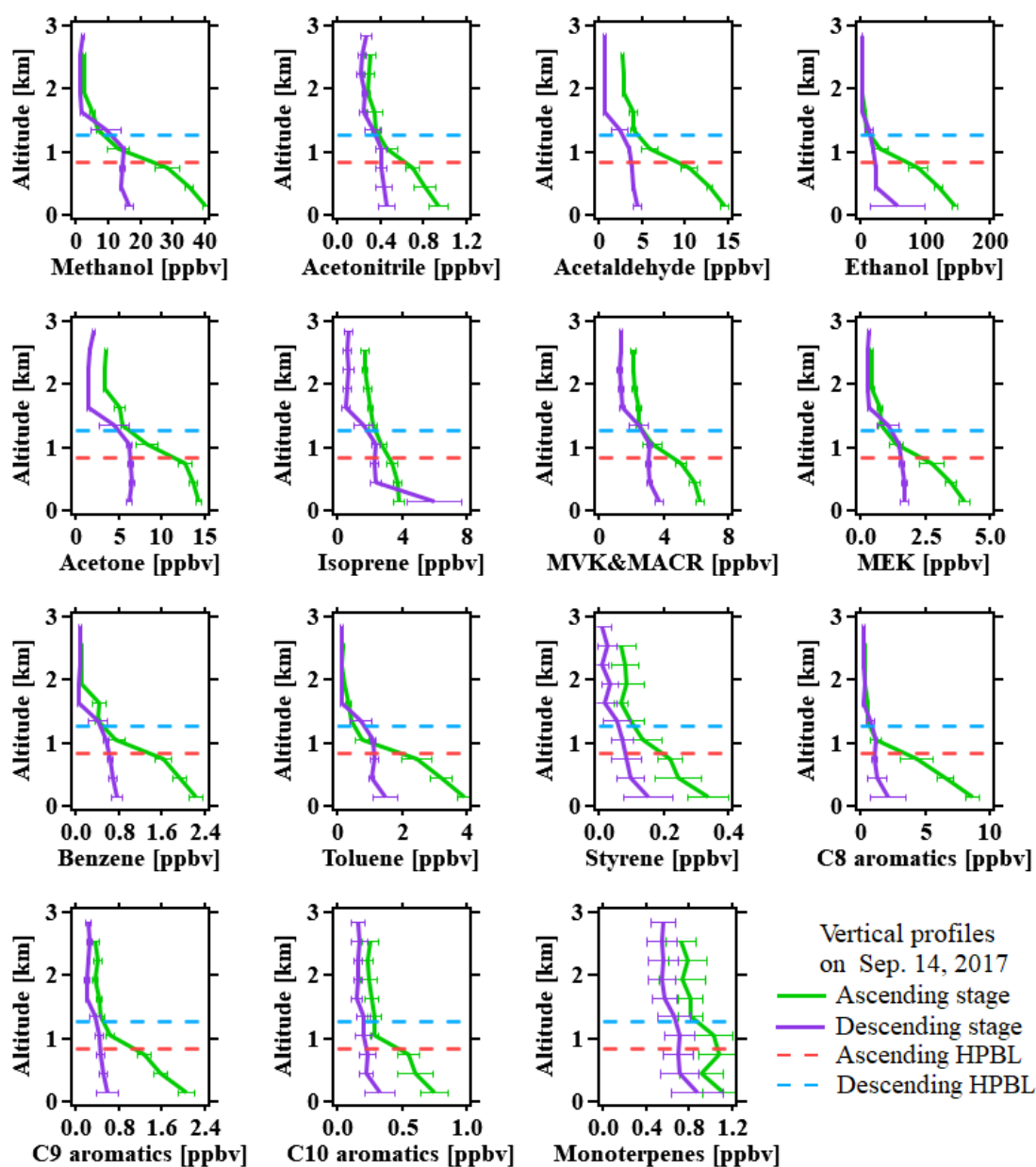
Figure S5. Vertical profiles of VOC mixing ratios during the ascending (in green) and

descending stages (in purple) for the aerial survey on Sep.14th, 2017, with error bars.

The red and blue dashed lines show the HPBL during the ascending and descending

stages, respectively.

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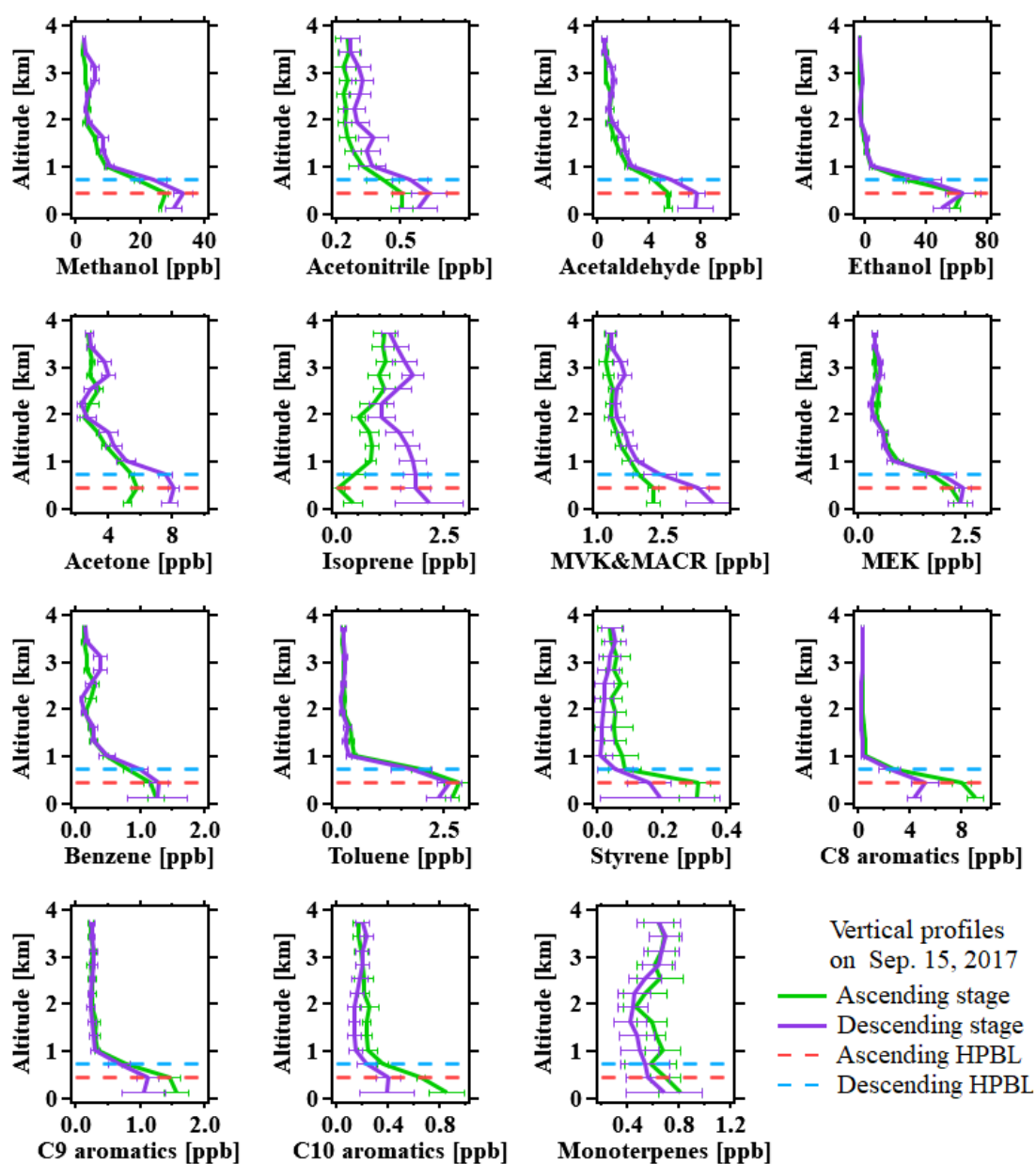
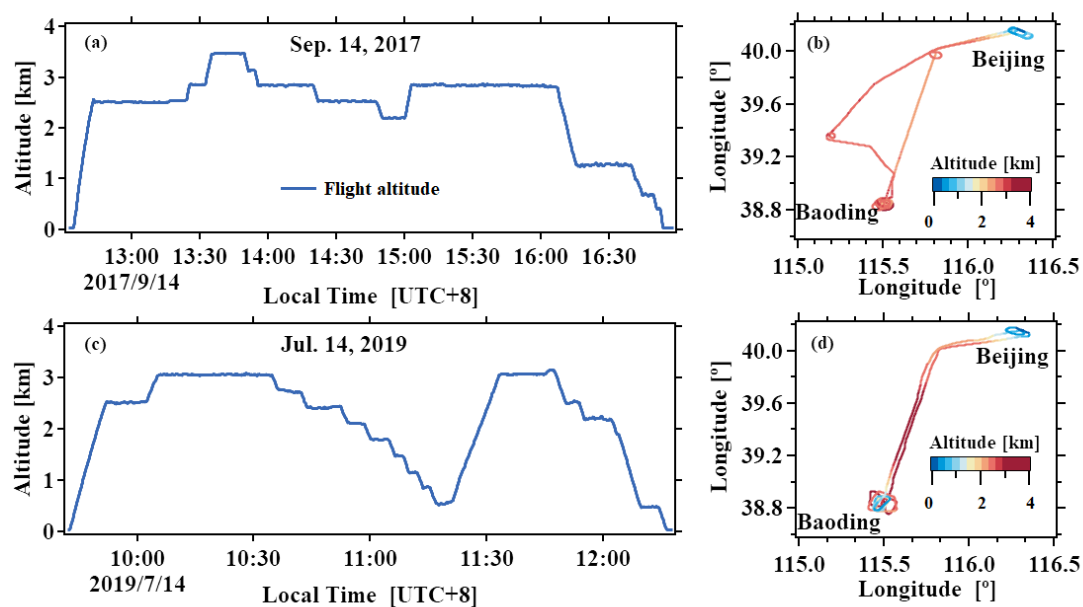


Figure S6. Vertical profiles of VOC mixing ratios during the ascending (in green) and descending stages (in purple) for the aerial survey on Sep.15th, 2017, with error bars. The red and blue dashed lines show the HPBL during the ascending and descending stages, respectively.

63

64 **Figure S7**. Time series of flight altitudes and flight routes on Sep.14th, 2017 (a, b) and

65 Jul. 14th, 2019 (c, d). The flight routes are color-coded with altitudes.

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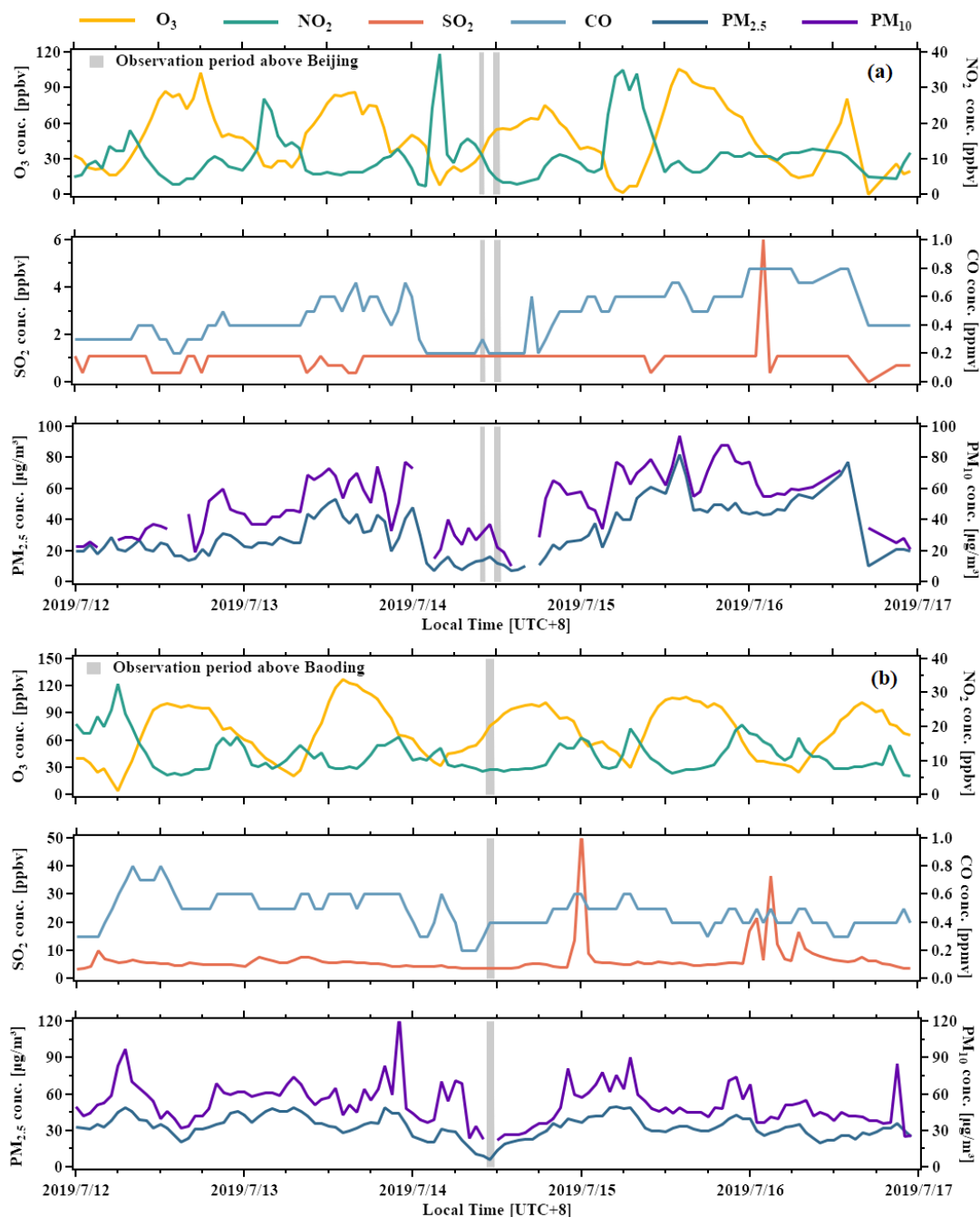
67 **Figure S8**. Time series of criteria pollutants including ozone, NO$_2$, SO$_2$, CO, PM$_{2.5}$,

68 and PM$_{10}$ on Sep. 14th, 2019, over Beijing (a) and Baoding (b). Data is obtained from

69 the Beijing Changping Town station and the Baoding natatorium station, the closest

70 national air quality monitoring stations to the flight trajectories. Shaded areas indicate

71 the observation periods.