

Supplementary materials for

Classification of summertime synoptic patterns in Beijing and relation to boundary layer structure affecting aerosol pollution

Yucong Miao¹, Jianping Guo¹, Shuhua Liu², Huan Liu¹, Zhanqing Li^{3,4}, Wanchun Zhang¹, and Panmao
5 Zhai¹

¹State Key Laboratory of Severe Weather, Chinese Academy of Meteorological Sciences, Beijing
100081, China

²Department of Atmospheric and Oceanic Sciences, Peking University, Beijing 100871, China

10 ³College of Global Change and Earth System Science, Beijing Normal University, Beijing 100875,
China

⁴Dept. of Atmospheric & Oceanic Sciences and ESSIC, University of Maryland, College Park, MD
20740, USA

15 Correspondence to: Jianping Guo (jpguocams@gmail.com) and Zhanqing Li (zli@umd.edu)

Table S1. The identified synoptic pattern types during summer from 2011 to 2014.

The date is presented as day/month, and the synoptic type (1 to 7) is shown in the bold number with shade.

2011						2012					
1/6	4	1/7	4	1/8	4	1/6	5	1/7	4	1/8	1
2/6	4	2/7	3	2/8	1	2/6	5	2/7	3	2/8	1
3/6	3	3/7	7	3/8	1	3/6	5	3/7	3	3/8	1
4/6	3	4/7	4	4/8	1	4/6	4	4/7	5	4/8	2
5/6	4	5/7	4	5/8	1	5/6	4	5/7	1	5/8	2
6/6	4	6/7	4	6/8	1	6/6	4	6/7	1	6/8	1
7/6	4	7/7	4	7/8	2	7/6	4	7/7	1	7/8	4
8/6	3	8/7	4	8/8	7	8/6	4	8/7	1	8/8	3
9/6	3	9/7	4	9/8	6	9/6	4	9/7	1	9/8	2
10/6	5	10/7	1	10/8	6	10/6	4	10/7	7	10/8	2
11/6	3	11/7	1	11/8	1	11/6	4	11/7	7	11/8	2
12/6	7	12/7	1	12/8	5	12/6	5	12/7	7	12/8	2
13/6	1	13/7	5	13/8	5	13/6	5	13/7	2	13/8	6
14/6	5	14/7	5	14/8	5	14/6	5	14/7	2	14/8	4
15/6	5	15/7	5	15/8	7	15/6	3	15/7	2	15/8	3
16/6	5	16/7	5	16/8	7	16/6	4	16/7	1	16/8	1
17/6	4	17/7	2	17/8	3	17/6	5	17/7	1	17/8	4
18/6	1	18/7	2	18/8	3	18/6	5	18/7	1	18/8	3
19/6	4	19/7	2	19/8	1	19/6	1	19/7	1	19/8	1
20/6	4	20/7	1	20/8	1	20/6	1	20/7	1	20/8	3
21/6	5	21/7	5	21/8	1	21/6	1	21/7	5	21/8	3
22/6	5	22/7	5	22/8	2	22/6	1	22/7	3	22/8	1
23/6	2	23/7	1	23/8	1	23/6	1	23/7	1	23/8	1
24/6	2	24/7	5	24/8	1	24/6	1	24/7	5	24/8	1
25/6	2	25/7	5	25/8	1	25/6	1	25/7	5	25/8	4
26/6	2	26/7	5	26/8	1	26/6	1	26/7	4	26/8	1
27/6	5	27/7	5	27/8	1	27/6	1	27/7	5	27/8	1
28/6	1	28/7	4	28/8	1	28/6	1	28/7	5	28/8	7
29/6	4	29/7	1	29/8	5	29/6	3	29/7	3	29/8	3
30/6	5	30/7	4	30/8	4	30/6	4	30/7	6	30/8	1
		31/7	4	31/8	3			31/7	1	31/8	1

2013						2014					
1/6	6	1/7	5	1/8	1	1/6	1	1/7	5	1/8	2
2/6	5	2/7	3	2/8	1	2/6	2	2/7	1	2/8	2
3/6	5	3/7	3	3/8	4	3/6	2	3/7	4	3/8	2
4/6	1	4/7	3	4/8	4	4/6	2	4/7	1	4/8	7
5/6	1	5/7	3	5/8	5	5/6	3	5/7	4	5/8	3
6/6	1	6/7	1	6/8	1	6/6	3	6/7	4	6/8	2
7/6	5	7/7	4	7/8	4	7/6	7	7/7	4	7/8	1
8/6	4	8/7	5	8/8	4	8/6	5	8/7	3	8/8	1
9/6	3	9/7	5	9/8	4	9/6	5	9/7	3	9/8	1
10/6	2	10/7	1	10/8	5	10/6	2	10/7	3	10/8	3
11/6	7	11/7	5	11/8	1	11/6	7	11/7	3	11/8	3
12/6	1	12/7	5	12/8	4	12/6	7	12/7	3	12/8	3
13/6	1	13/7	5	13/8	4	13/6	7	13/7	3	13/8	4
14/6	1	14/7	1	14/8	4	14/6	6	14/7	5	14/8	4
15/6	4	15/7	5	15/8	5	15/6	5	15/7	5	15/8	4
16/6	4	16/7	4	16/8	4	16/6	5	16/7	5	16/8	5
17/6	3	17/7	1	17/8	3	17/6	5	17/7	5	17/8	1
18/6	3	18/7	5	18/8	3	18/6	3	18/7	5	18/8	2
19/6	3	19/7	5	19/8	3	19/6	1	19/7	1	19/8	1
20/6	2	20/7	6	20/8	1	20/6	1	20/7	4	20/8	4
21/6	7	21/7	1	21/8	4	21/6	2	21/7	3	21/8	1
22/6	1	22/7	1	22/8	3	22/6	2	22/7	3	22/8	1
23/6	1	23/7	4	23/8	3	23/6	6	23/7	3	23/8	3
24/6	1	24/7	3	24/8	3	24/6	4	24/7	2	24/8	3
25/6	5	25/7	6	25/8	3	25/6	4	25/7	2	25/8	3
26/6	5	26/7	5	26/8	6	26/6	3	26/7	1	26/8	4
27/6	5	27/7	5	27/8	1	27/6	7	27/7	1	27/8	1
28/6	5	28/7	4	28/8	5	28/6	7	28/7	4	28/8	1
29/6	5	29/7	4	29/8	7	29/6	6	29/7	5	29/8	1
30/6	5	30/7	1	30/8	3	30/6	1	30/7	1	30/8	1
		31/7	1	31/8	3			31/7	1	31/8	2

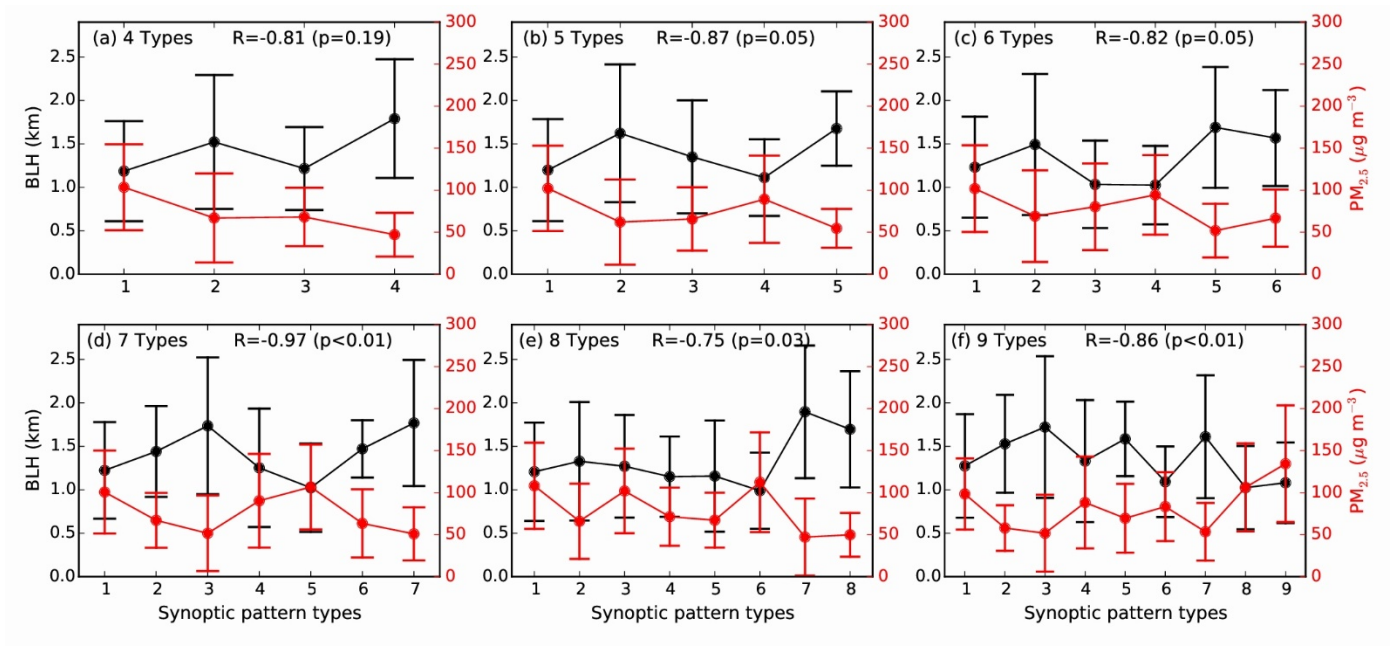


Fig. S1. Boundary layer height (BLH, in black) at 1400 BJT and daily PM_{2.5} concentration (in red) as a function of synoptic pattern types, which are identified using T-PCA method with (a) 4 principle components (PCs), (b) 5 PCs, (c) 6 PCs, (d) 7 PCs, (e) 8 PCs, (f) 9 PCs. Mean values \pm one standard deviation are shown. The correlation coefficient (R) between the averaged BLH and PM_{2.5} concentration of different synoptic patterns for each panel is also given.

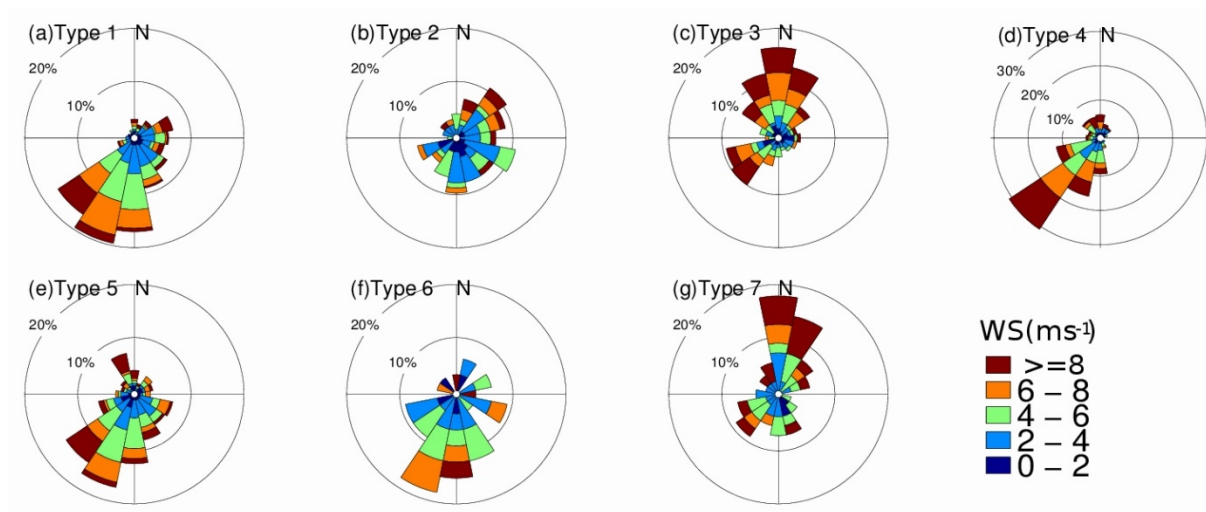


Fig. S2. The 925-hPa wind rose diagrams associated with different synoptic types. The 925-hPa wind speed (WS) and wind direction were derived from the summertime soundings from 2011 to 2014 in Beijing.

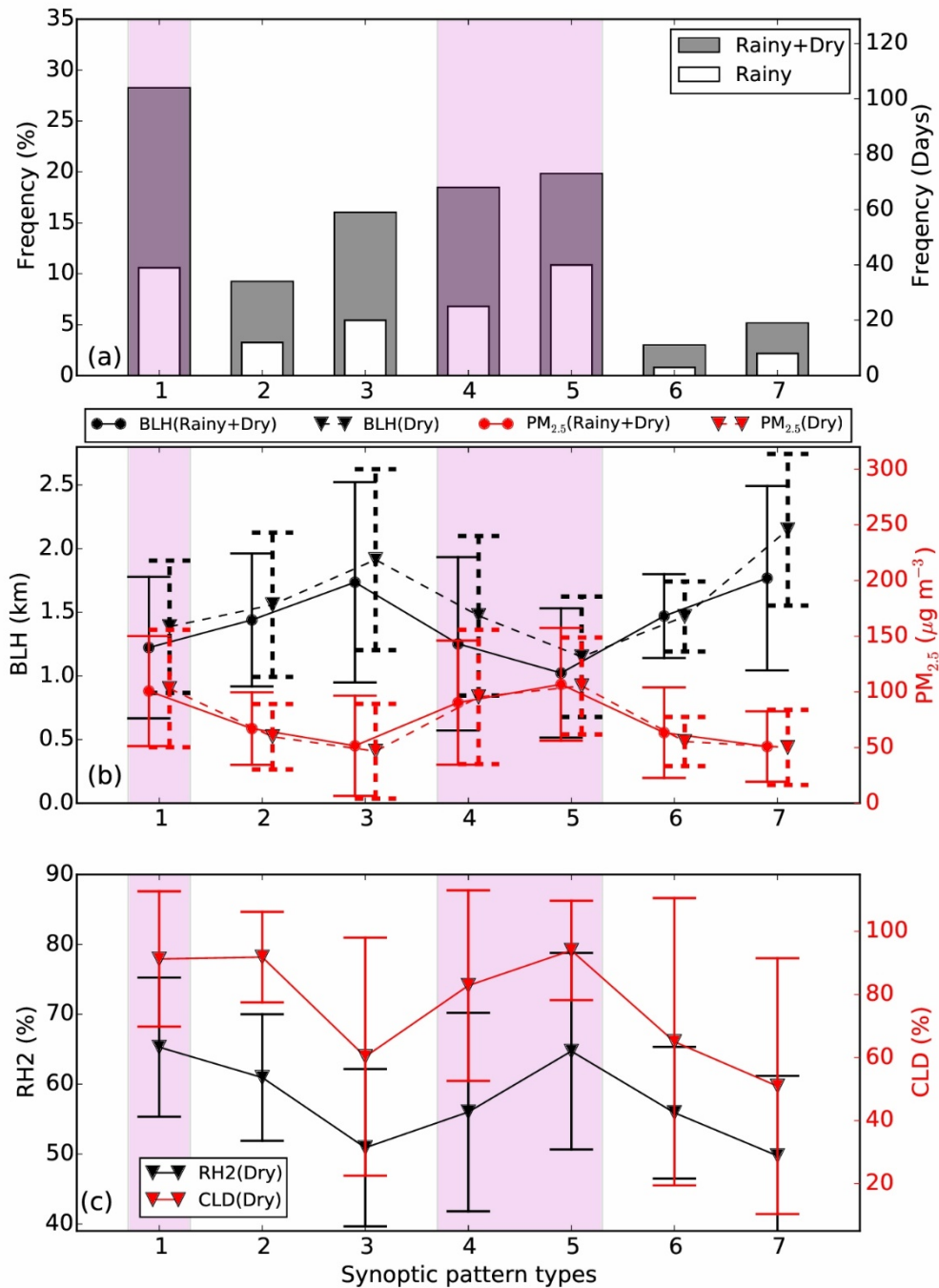


Fig. S3. (a) The occurrence frequency, (b) boundary layer height (BLH) at 1400 BJT and daily PM_{2.5} concentration, (c) daily 2-m relative humidity (RH2) and total cloud cover (CLD) at 1400 BJT of different synoptic patterns derived from the summertime observations from in Beijing (39.80 °N, 116.47 °E) from 2011 to 2014. The corresponding values excluded observations of rainy days (Dry) are also illustrated in (b) and (c). The pink shades mark the three synoptic patterns have relatively severe aerosol pollution, including the Type 1, Type 4, and Type 5.

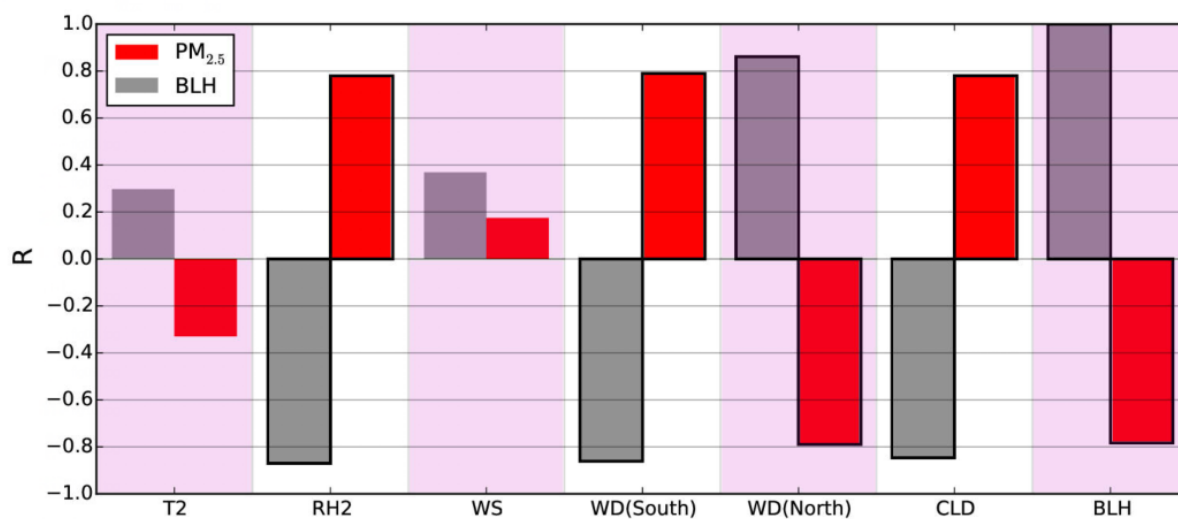


Fig. S4. Correlations (R) between the mean values of $PM_{2.5}$ concentration and meteorological parameters for the different synoptic patterns, including (from left to right) 2-m temperature (T2), 2-m relative humidity (RH2), wind speed at the 925-hPa level (WS), south- and north- wind frequencies at the 925h-hPa level (WD), total cloud cover at 1400 BJT (CLD), and the BLH at 1400 BJT. The grey bars represent the correlations between BLH and these meteorological parameters. Bars outlined in thick black lines indicate correlation coefficients (R) that are statistically significant ($p < 0.05$). Note that the observations of rainy days are not considered.