Supplement:

S1. WRF Domains

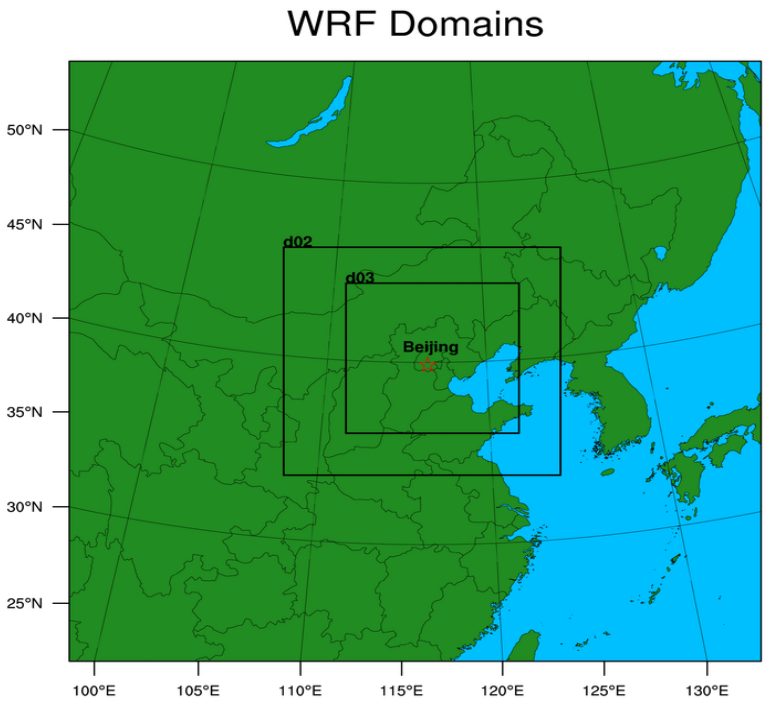

Figure S1. WRF domains 1-3.

S1.2 Comparison of WRF outputs with the in-situ observations.

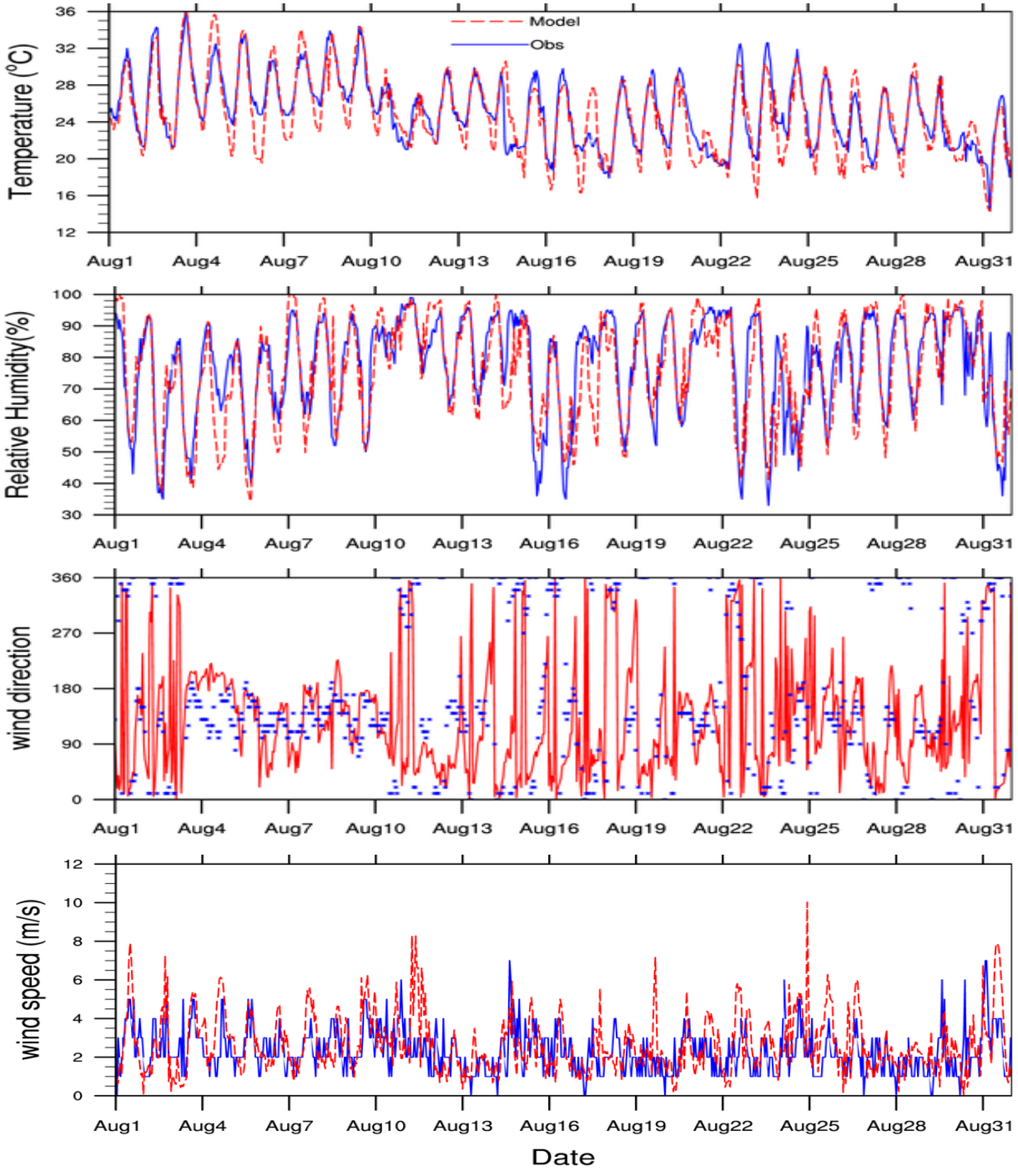

Figure S2. Comparison of model hourly outputs from 4 km WRF simulation (red line) with observed hourly temperature, relative humidity (at 2 m), wind speed and wind direction at 10 m (blue line or dot) at Beijing Capital International Airport (40.06°N, 116.58°E) for August 2008.

S2. 500-hPa geopotential height during the pre-Olympics, Olympics and the period from 21 July to 08 August 2000-2009.

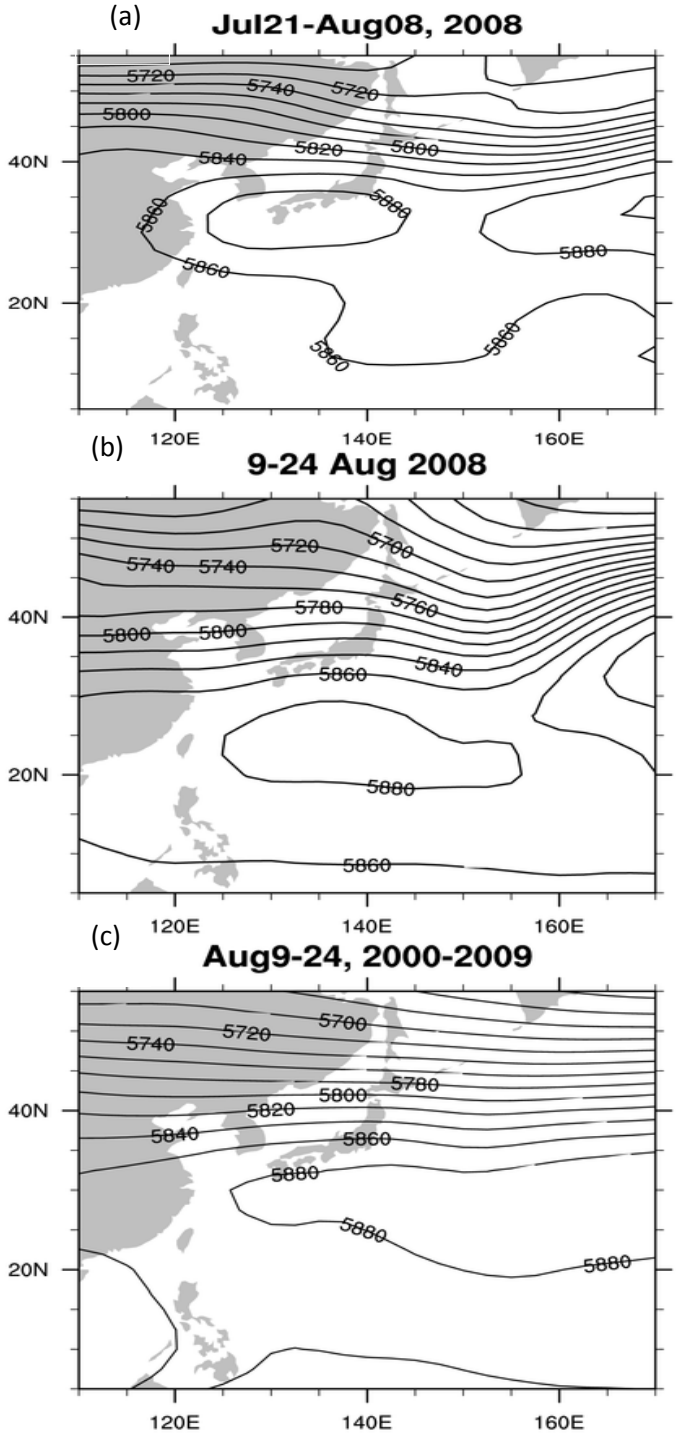

Figure S3. 500-hPa geopotential height (gpm) during (a) the pre-Olympics (21 July – 08 Aug, 2008), (b) Olympics (09-24 Aug, 2008) and (c) the period from 21 July to 08 August 2000-2009.

S3. Statistical difference of the mean of the meteorological variables among the circulation types.

Table S1. Statistical difference of the mean of the meteorological variables among the different circulation types, at a significance level of 0.05, during 2000-2009.

Circulation type	Temperature	Relative Humidity	Surface Pressure	Wind speed	Cloud cover	Visibility
1	2,3,4,5,6,7,8,9	2,3,4,5,6,7,8,9	2,3,4,5,6,7,8,9	2,3,4,5,6,7,8,9	2,3,4,5,6,7,8,9	2,3,4,5,6,7,8,9
2	1,3,4,5,6,7,8,9	1,4,5,7,8,9	1,3,4,5,6,7,8,9	1,3,4,5,6,7,8,9	1,3,4,6,7,8,9	1,3,4,5,6,7,8,9
3	1,2,4,5,6,7,8	1,4,5,7,8,9	1,2,4,5,6,7,8,9	1,2,4,8,9	1,2,5,6,7,8,9	1,2,4,5,6,7,8,9
4	1,2,3,5,8,9	1,2,3,5,6,7,8,9	1,2,3,5,7,8	1,2,3,5,6,7	1,2,5,6,7,8,9	1,2,3,5,6,8,9
5	1,2,3,4,6,7,8	1,2,3,4,6,7,8,9	1,2,3,4,6,7,9	1,2,4,9	1,3,4,6,7,8,9	1,2,3,4,6,7,8,9
6	1,2,3,5,8,9	1,4,5,7,8,9	1,2,3,5,7,8	1,2,4,8,9	1,2,3,4,5,7,8	1,2,3,4,5,7,8,9
7	1,2,3,5,8,9	1,2,3,4,5,6,8,9	1,2,3,4,5,6,8,9	1,2,4,9	1,2,3,4,5,6,8,9	1,2,3,5,6,8,9
8	1,2,3,4,5,6,7,9	1,2,3,4,5,6,7,9	1,2,3,4,6,7,9	1,2,3,6	1,2,3,4,5,6,7,9	1,2,3,4,5,6,7
9	1,2,4,6,7,8	1,2,3,4,5,6,7,8	1,2,3,5,7,8	1,2,3,5,6,7	1,2,3,4,5,7,8	1,2,3,4,5,6,7

S4. Statistical difference of the mean for the air quality parameters among the circulation types.

Table S2. Statistics of visibility and AERONET AOD for the nine circulation types.

Circulation Type	Visibility (km)				Aeronet AOD (Beijing site)			
	Median	Mean	Std dev	Statistical difference*	Median	Mean	Std dev	Statistical difference*
1	18.73	18.49	8.26	2,3,4,5,6,7,8,9,	0.18	0.26	0.26	2,3,4,5,6,7,8,9,
2	10.62	12.4	7.61	1,3,4,5,6,7,8,9,	0.37	0.56	0.55	1,4,5,7,8,9,
3	9.17	11.11	7.68	1,2,4,5,6,7,8,9,	0.46	0.6	0.5	1,5,7,8,9,
4	7.97	9.42	5.94	1,2,3,5,6,8,9,	0.49	0.69	0.57	1,2,5,6,8,9,
5	5.61	5.99	3.47	1,2,3,4,6,7,8,9,	1.05	1.15	0.59	1,2,3,4,6,7,
6	12.45	14.33	8.45	1,2,3,4,5,7,8,9,	0.29	0.5	0.5	1,4,5,7,8,9,
7	8.19	9.78	6.51	1,2,3,5,6,8,9,	0.64	0.79	0.61	1,2,3,5,6,8,9,
8	6.04	6.57	3.73	1,2,3,4,5,6,7,	0.93	1.02	0.57	1,2,3,4,6,7,
9	6.35	6.67	3.64	1,2,3,4,5,6,7,	0.99	1.13	0.63	1,2,3,4,6,7,

* Statistical difference of the mean visibility and mean of the AOD among the different circulation types, at a significance level of 0.05.

Table S3. Statistics of PM_{10} concentrations and BC concentration ($\mu g\ m^{-3}$) for the nine circulation types.

Circulation Type	PM_{10} ($\mu g\ m^{-3}$)				BC ($\mu g\ m^{-3}$)			
	Median	Mean	Std dev	Statistical difference*	Median	Mean	Std dev	Statistical difference*
1	70.6	90.3	76.3	2,3,4,5,6,7,8,9,	2.94	4.13	3.76	2,3,4,5,6,7,8,9,
2	122	143.2	97.9	1,5,6,	5.15	5.72	3.49	1,3,5,6,8,9,
3	111.2	140.4	106.6	1,5,6,	6.04	7.28	5.36	1,2,6,
4	122.3	142.8	102.3	1,5,6,	5.41	6.25	4.55	1,5,6,8,
5	155.4	173.4	105.8	1,2,3,4,6,7,	7.44	8.44	4.89	1,2,4,6,7,9,
6	90.4	111.7	89.6	1,2,3,4,5,7,8,9,	3.97	4.82	3.44	1,2,3,4,5,7,8,9,
7	109.1	133.2	91.1	1,5,6,8,	5.52	6.47	4.36	1,5,6,8,
8	146.1	158.4	90	1,6,7,	6.62	7.61	4.35	1,2,4,6,7,9,
9	136.2	151.2	93.1	1,6,	6.01	6.74	3.85	1,2,5,6,8,

* Statistical difference of the mean BC and mean of the PM_{10} among the different circulation types, at a significance level of 0.05.

Table S4. Statistical difference of the mean SO_2, NO_2, O_3 and CO mixing ratio for the nine circulation types.

Circulation Type	SO_2 (ppbv)		NO_2 (ppbv)		O_3 (ppbv)		CO (ppmv)	
	Mean	Statistical difference*	Mean	Statistical difference*	Mean	Statistical difference*	Mean	Statistical difference*
1	22.5	2,6,7,8,	29.51	3,5,7,8,9,	46.19	2,5,6,8,9,	1.39	5,7,9,
2	12.5	1,3,4,5,7,9,	33.82	5,6,9,	69.07	1,4,7,	1.32	4,5,7,8,9,
3	20.77	2,6,8,	36.68	1,6,	61.72		1.68	6,
4	21.72	2,6,8,	32.12	5,6,7,9,	49.03	2,5,8,9,	1.7	2,6,
5	21.34	2,6,8,	42.19	1,2,4,6,8,	69	1,4,	2.61	1,2,6,
6	11.89	1,3,4,5,7,9,	27.3	2,3,4,5,7,8,9,	60.35	1,	1.2	3,4,5,7,8,9,
7	29.16	1,2,6,8,9,	38.25	1,4,6,	52.32	2,8,9,	2.04	1,2,6,8,
8	12.99	1,3,4,5,7,9,	35.23	1,5,6,	71.49	1,4,7,	1.6	2,6,7,
9	18.78	2,6,7,8,	39.06	1,2,4,6,	70.73	1,4,7,	2.03	1,2,6,

* Statistical difference of the mean SO_2 and NO_2 mixing ratio among the different circulation types, at a significance level of 0.05.

S5. Description of the error calculation method for the effects of air quality parameters in improving air quality during the 2008 Beijing Olympics

Error estimation:

1. Assumption: The air quality parameters for each CT were with lognormal distribution.
2. According to the error propagation formulas, the climatological mean and standard deviation of each air quality parameters were used to calculate the error estimation for evaluating the relative role of circulation types in improving air quality during the Olympic.