Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2017-114-AC1, 2017

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of emission reduction and meteorological conditions on air quality improvement during the 2014 Youth Olympic Games in Nanjing, China" *by* Qian Huang et al.

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Received and published: 8 June 2017

Thank you very much for reviewing the manuscript and providing us the constructive comments and suggestions on our study. We have learned a lot from your advice and revised the manuscript, which we hope meet with approval. And point-by-point responses are listed as below:

Responses to the reviewer's comments:

Comment 1: This manuscript described a study for the emission control scenario

during the 2nd Youth Olympic Games in Nanjing using surface measurements and WRF/CMAQ model. This manuscript's English need improvement. It listed both model and measurement results, but it is not easy to track which is about observation and which is about the model. I suggest add something to make it clear. For instance, the title of section 3.1 can be "Observed air quality during YOG", and the section 3.2 changes to be "simulated impact of meteorological conditions". Response: Thank you for your advice. We have followed your advice and modified the manuscript to make observation part and modeling part more clearly. The title of section 3.1 can be "Observed air quality during YOG", and the section 3.2 changes to be "simulated impact of meteorological conditions".

Comment 2: Another issue is that the discussions for the measurements and model are totally separated, and the modeled impact of NOx emission reduction on O3 et al is not supported by the observation. Obviously the model or emission inventory has some biases, which should be addressed. Response: Thank you for your advice. The measurements and model are separated because we want to investigate the variations of air pollutants from different point of view, one is the real reduction of air pollution from observation, the other is model reduction from meteorology and emission. The observational decrease of O3 may due to the meteorological conditions. In Aug. 2014, there were more overcast days, and the reduction in solar radiation could restrain the production of O3. However, in the model simulation, underestimation of cloud cover could result in more solar radiation, which was conductive to the promotion of O3. Besides, reduction of NOx could result in less titration of O3 by NOx, which also lead to higher simulation O3. Thus, the observational O3 variation and the model simulation O3 variation are different, which was discussed in section 3.3.

Comment 3: Another issue is that this study did not discuss anything about emission and pollutant concentrations in surrounding areas, which sometimes can affect your results. Response: Thank you for your comment. During the YOG holding month (Aug. 2014), though the surrounding area of Nanjing had taken part in the pollution emission

control, their magnitudes of emission reduction were very small. And the emission reduction were mainly concentrated in the holding city, Nanjing, so we focus on the local emission and pollutant concentrations.

Comment 4: Page 1, line 27, “However, simulation” better to be “However, the model simulation” Response: We are grateful for your suggestion. We have followed your advice and modified the manuscript (Line 27, Page1).

Comment 5: Page 1, line 28, “and raised SO2” better to be “and could increase” Response: We have modified it according to the comment (Line 29, Page1).

Comment 6: Page 2, line 48-49, “Preparatory work were carried out since 1 Jul., 2014” better to be “The preparation started from Jul. 1, 2014”. Response: We have changed it according to the suggestion (Line 48-49, Page 2).

Comment 7: Page 2, line 54-59. Please consider to split that long sentence to several sentences as it has grammar errors. Response: Thank you for your advice. We have followed your suggestions and modify the manuscript. And the sentences (Line 52-57, Page 2) have been rephrased as follows: Some local petrochemical, chemical and steel industries were forced to limit or halt their production. Coal-combustion enterprises were required to use high-quality coals with low sulfur content and ash content. And heavy pollution vehicles called “yellow label buses” were prohibited in Nanjing during 10-28 Aug.. Oil loading and unloading operations were strictly controlled. Construction process was forced to stop.

Comment 8: Page 4, line 137. “Exp.3 had the same inventory as Exp.2 but the weather” better to be “Exp.3 had the same inventory as Exp.2 but used the weather” Response: We have changed it according to the suggestion (Line 203, Page 8).

Comment 9: Page 4, line 141. “meteorology on contaminants” better to be “meteorology on air quality” . Response: We have changed it according to the suggestion (Line 206, Page 8).

Comment 10: This manuscript should show a map of the emission reduction for Exp1 - Exp2, instead of just modeled concentration changes. Response: Thank you for your advice. We have add some introduction of the emission inventory used in model simulation in Section 2.3 Emissions and simulation scenarios and offer the map (See Fig.2) of the emission reduction for Exp.1 - Exp.2.

Comment 11: Page 8, line 184, “most species had a good reflection”, What does it mean? Response: Thank you for your comment. We’re sorry about the confusing sentence and have rewritten it. It means the concentrations of most species decreased obviously in Aug. 2014 compared with those in Jul. 2014 and Sept. 2014 (Line 249, Page 11).

Comment 12: Page 8, line 186-194. Please re-write to make it easy to understand. Response: Thank you for your suggestion. We have rewritten the sentences (Line 251-260, Page 11).

Comment 13: Figure 6, 7 and the corresponding discussion in section 3.2. Are those comparisons for monthly averaged value, such as 10m wind, PBL heights? If so, please state it. Response: Thank you for your comment. We have completed the captions of the figure (Line 325-328). And Figure 7 shows hourly average values of impact percentage (dspecies (%)= (Exp.2 - Exp.3)/Exp.2 * 100%) of SO2, NO2, PM10, PM2.5, CO, and O3, respectively. To better display the bias of meteorological parameters, Figure 6 was replaced by Figure 8 in the revised manuscript (Line 329-334, Page 16), they’re hourly average values.

Comment 14: Page 13, line 257-259. The O3 increase should be due to the NOx emission reduction -> less titration.ãĂĂ Response: Thank you for your comment. We have corrected it (Line 340-342, Page 16) as follows: “As for O3, the variation was positive, especially in the downwind area of NOx heavy reduction region, which might due to the less titration of O3 by NOx”

Comment 15: Page 14, table 6. Why the modeled impact of the emission reduction

on NO2, O3, PM10, PM2.5 diff significantly from the observations? You may discuss it. Response: Thank you for your suggestion. As discussed in Section 2.3 (Line 197-206), the simulation scenarios are reasonable. And the dynamic parameterization in WRF as well as the physical and chemical schemes of CMAQ applied in this research were the same as those in the research of Shu et al.(Shu is a member of our research group). The model performance has been validated by Shu et al., and they proved that WRF/CMAQ is reliable as shown in the uploaded Fig.1 and Fig.2.

Several factors contribute to the bias of NO2, O3, PM10, PM2.5 between simulation and observation. Firstly, a overall underestimation of emission reduction might result in less variations of NO2, PM10, and PM2.5 caused by emission abatement. Secondly, the observational O3 decreased during the emission control month (Aug. 2014) while the simulation O3 increased slightly under emission control, which can be affected by the cloud simulation and the modeling chemical mechanism. During Aug. 2014, there were more overcast days, which may cause less solar radiation and was adverse for the promotion of O3. However, the underestimation of modeling cloud cover could lead to higher simulation O3. Besides, reduction of NOx could result in less titration of O3 by NOx, and overestimation of this chemical mechanism could also lead to higher simulation O3. What's more, the aim of Table 6 (Page 18) is to compare the simulated effect of meteorological conditions and emission reduction other than comparing the simulation with the observation. It want to indicate that the adverse meteorological conditions in Aug. 2014 could cause the increase of pollution concentrations while emission reduction could help to cut down the pollutants' (SO2, NO2, CO, PM10, and PM2.5) level during Aug. 2014.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2017-114, 2017.

Table 3. Comparisons between the simulations and the observations at Shanghai, Nanjing and Hangzhou stations during 4–15 August 2013.

Site[a]	Vars[b]	Mean		R[e]	NMB[f]	RMSE[g]
		OBS[c]	SIM[d]			
SH	T_2 (°C)	33.27	31.38	0.91	−5.68 %	4.15
	RH_2 (%)	57.91	65.23	0.85	12.64 %	19.3
	$Wspd_{10}$ ($m\,s^{-1}$)	4.59	4.66	0.77	1.53 %	2.18
	$Wdir_{10}$ (°)	176.34	182.57	0.63	3.53 %	41.44
	O_3 (ppb)	87.77	82.5	0.81	−6.00 %	38.79
	NO_2 (ppb)	29.01	38.25	0.54	31.85 %	28.95
NJ	T_2 (°C)	32.95	30.98	0.84	−5.98 %	2.91
	RH_2 (%)	63.28	66.14	0.83	4.52 %	9.41
	$Wspd_{10}$ ($m\,s^{-1}$)	3.21	3.4	0.74	5.92 %	2.41
	$Wdir_{10}$ (°)	197.68	194.58	0.57	−1.57 %	71.19
	O_3 (ppb)	69.7	78.15	0.81	12.12 %	36.8
	NO_2 (ppb)	41.44	40.09	0.61	−3.26 %	22.4
HZ	T_2 (°C)	33.25	31.08	0.8	−6.53 %	3.09
	RH_2 (%)	52.76	61.39	0.78	16.36 %	13.96
	$Wspd_{10}$ ($m\,s^{-1}$)	3.04	3.32	0.75	9.21 %	2.39
	$Wdir_{10}$ (°)	186.45	186.2	0.58	−0.13 %	69.44
	O_3 (ppb)	76.57	84.51	0.83	10.37 %	33.95
	NO_2 (ppb)	31.06	27.21	0.66	−12.40 %	16.86

[a] Site indicates the city where the observation sites locate, including Shanghai (SH), Nanjing (NJ) and Hangzhou (HZ). [b] Vars indicates the variables under validation, including 2 m air temperature (T_2), 2 m relative humidity (RH_2), 10 m wind speed ($Wspd_{10}$), 10 m wind direction ($Wdir_{10}$), ozone (O_3) and nitrogen dioxide (NO_2). The words between the parentheses behind variables indicate the unit. [c] OBS indicates the observation data. [d] SIM indicates the simulation results from WRF/CMAQ. [e] R indicates the correlation coefficients, with statistically significant at 95 % confident level. [f] NMB indicates the normalized mean bias. [g] RMSE indicates the root-mean-square error.

Fig. 1. Figures for Comment 15, Fig1. model performance

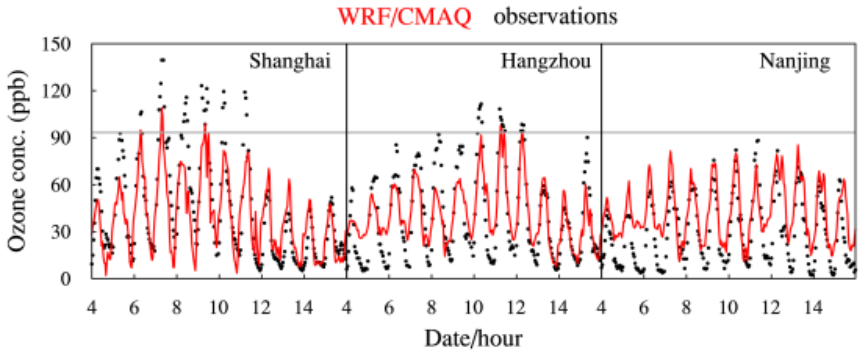

Figure 6. Hourly variations of the observed and the simulated O_3 concentrations in Shanghai, Nanjing and Hangzhou during 4 to 15 August 2013. The red solid lines show the modeling results, the black dot lines give the observations, and the solid gray lines represent the national standard for the hourly O_3 concentration, which is 200 $\mu g\, m^{-3}$.

Fig. 2. Figures for Comment 15, Fig2. model performance