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Interactive comment on "Measurement and model analyses of the ozone variation during 2006 to 2015 and its response to emission change in megacity Shanghai, China" *by* Jianming Xu et al.

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Responses to Reviewers:

Reviewer 2:

We thank the reviewer for the careful reading of the manuscript and helpful comments. We have revised the manuscript following his/her suggestions as is described below.

(1) The manuscript analyzed the ozone concentration variation based on the measurement of 2006-2015 in Shanghai with the simulation in September 2009. Please clarify the connection between the measurement and model analyses of the ozone variation

and the limitations in conclusions from modeling study. First, we found the notable increasing trend of O3 concentration at XJH and PD sites during 2006 to 2015 based on the long term measurements. By excluding the effects of VOCs and meteorology on the measured O3 enhancement, we speculated that the O3 increasing trend in Shanghai was likely attributed to the reduction of NOx concentration as a result of the strong VOCs-limited regime for O3 production according to the previous studies. Then we used the WRF-Chem model to conduct sensitive experiments to demonstrate the abovementioned speculation. The simulated O3 concentration increased from 2009 to 2015 resulted from 30% reduction of NOx emission estimated by Shanghai Environmental Monitoring Center. The increasing rates of O3 trend at downtown site XJH and sub-urban site PD were estimated by WRF-Chem model at 1.06 ppbv yr-1 and 0.96 ppbv yr-1, which was very close to the observed O3 growth variability. Thus we suggested that the observed increasing trend of O3 concentration during the past ten years in Shanghai was mainly attributed to the reduction of NOx emission under the VOC-limited condition for O3 production. However there were some uncertainties and limitations existed in the study. First, in sensitive experiments the NOx emission was cut evenly for all the grids of model domain, that was to say the inhomogeneity of the NOx reduction was not considered in the sensitive experiments by lacking of the emission inventory with higher resolution. Second, the variation of VOCs emission was not taken into account due to the more uncertainties of the current inventory for VOCs. According to the studies of Geng et al. (2007, 2009), O3 production in Shanghai was very sensitive to some VOC species, especially aromatics. Thus the accurate emission of VOCs need to be developed and included in the future study. Third, the same meteorology was used for all WRF-Chem experiments. However the O3 photolysis, advection, and vertical diffusion were strongly affected by meteorology. For example, O3 concentration in Shanghai was depressed in June due to the Meiyu period with great cloud cover inhibiting the photolysis. The summer O3 concentration was mostly affected by the location and intensity of sub-tropical high which was dominant for the photochemical production. Thus the variation of meteorology would be considered and

evaluated in the future studies for more deep investigation. Above discussion has been complemented in the part of Conclusion.

(2) It is better to add the discussions in the measurement analyse on the interannual variations in seasonal cycle (monthly change) of daytime/ nighttime O3 concentrations over 2005-2016. Thanks for the suggestion. The seasonal variability of daytime and nighttime O3 concentrations at XJH site were presented in the new Fig. 7. Both daytime and night O3 concentrations presented increasing trends in all seasons. In comparison, the larger increasing rates of nighttime O3 concentration were observed in spring, summer and autumn than that of daytime O3 concentrations. For example, the nighttime O3 concentrations increased at 1.341, 1.159 and 1.525 ppbv yr-1 in spring, summer and autumn respectively, which were more significant than that of 1.008, 0.378 and 1.370 ppbv yr-1 in daytime. The variability of winter O3 concentrations in daytime and nighttime were generally close perhaps due to the lower O3 photochemical productions. The above results have been included in the Fig.7.

Fig.7 The variability of daytime and night O3 concentration during 2006 to 2015 at XJH in (a) spring, (b) summer, (c) autumn, (d) winter respectively.

(3) Lines 201-212: Please present the resolution of emission used in WRF-Chem modeling. The emission inventory used in WRF-Chem was extracted and combined from MEIC (Zhang et al., 2009) with 0.25o resolution for the domain out of Shanghai and the MIRAGE-shanghai (Tie et al., 2011) with 0.16o resolution for Shanghai area, which has been introduced in Sect. 2.3.

(4) Please clarify which year the meteorology is used in the modeling experiment of 2020 ozone. The meteorology in September of 2009 was used for the all experiments by WRF-Chem considering that it was very close to the climatological condition in Shanghai.

The complete response including text and figures was upload in supplement.

Please also note the supplement to this comment:
https://www.atmos-chem-phys-discuss.net/acp-2019-160/acp-2019-160-AC2-supplement.pdf

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