Answer to the comments by #2 Referee

1) *The employed horizontal resolution is 45 km for all the models, and the highest height and number of vertical layers are 45 km and 40 layers for the CMAQ models and 20 km and 20 layers for the NAQM so that the vertical resolution in the troposphere is about the same. The top height of 45 km sounds really high. What is the top pressure of the CMAQ model?*

The top pressure of the CMAQ is ca. 52-53 hPa.

2) **Line 105:** *CMAQ v.4.7.1 and v.5.0.2 included AERO6 There was no AERO6 mechanism in CMAQ v4.7.1. 3*

We corrected AERO6 to AERO5 for CMAQ5.7.1.

3) *The quality of the figures might be improved: 1) Figure 2: It should be better if the labels were added inside each plot. For example, O_3 in April, O_3 in July, NO in April, NO in July can be added on the top corner of each panel*

Thank you for the comment. We improved the quality of Figures checking all of them.

4) **Line 197:** *A morning peaks (grammar issue)*

Thank you for your alert. We corrected.

5) **Line 237:** *Figures 5 (a)-(d) show the net chemical production of O3 in Beijing and Tokyo in April and July calculated in this study. More details need to be described. For example, how did the authors calculate the net chemical production? Did the authors add some diagnostic equations or use some internal diagnostic packages to get the net chemical production? Did the authors calculate the production in each grid and did average of all the grids at the end?*

We agree with the reviewer comments and we added the definition of "net chemical production of O_3" explicitly in the text. We calculated the production in each grid and did average of all the grids at the end. The added sentences are on page 8 (Line 251-256).

"Here, the net chemical production, $N(O_3)$, is calculated by the equation, $N(O_3) = F(O_3)\text{-}D(O_3)=\{k_1[HO_2][NO]+k_2[RO_2][NO]\}\text{-}\{k_3[O(^1D)][H_2O]+k_4[OH][O_3]+k_4[HO_2][O_3]+k_5[O_3][olefin]\}$ in NAQM. The CMAQ models give the net chemical production as the difference of O_3 mixing ratio between the calculation steps of chemistry module with a process analysis package. The net chemical production was calculated in each grid and then average was taken for all the selected grids."

6) **Line 284:** *observatiional Typo: observational*

We corrected.

7) **Line 250-253:** *The authors tried to explain the overestimation in Fig. 2b and Fig. 3b for NAQM. The peak in Fig. 5b,d seems to support the overestimation. However, I feel the evidence is not strong. In Fig. 5d, the net reaction is negative, I am not sure how the negative production contributes to the ozone overestimation. In addition, the morning peak is obvious in Fig. 5a,c as well, why is there no overestimation in Fig. 2a and Fig. 3a if the early morning peak may result in the over shooting of ozone?*

We agree with the reviewer that the explanation of O_3 overestimation by NAQM in early morning by the morning peaks of net-chemical production is not very strong since no quantitative sensitivity check has been done in this study. We modified the expression as follows (page 9, Lines 270-276).

Original version: "It can be noted that net O_3 production of NAQM shows a second peak in early morning after breaking of dawn in both Beijing and Tokyo in July, which would be a cause of overestimate of O_3 in the morning by NAQM simulation as seen in Fig. 2(b) and Fig. 3(b). The cause of the early morning peak of net O_3 production in NAQM might be due to the photolysis of higher HONO that is produced by the heterogeneous reaction of NO_2, although it has not been quantified in the present study."

Revised version: "It can be noted that net O_3 production of NAQM shows a peak in early morning after breaking of dawn in both Beijing and Tokyo, which could be a cause of overestimate or earlier rise of O_3 in the morning by NAQM simulation as seen in Fig. 2(a), (b) and Fig. 3(a), (b) although the effect is marginal in the case of Beijing in April. The

cause of the early morning peak of net O_3 production in NAQM might be due to the photolysis of higher HONO that is produced by the heterogeneous reaction of NO_2. More quantitative sensitivity analysis should be performed to confirm these effects. ”

8) **Line 257-259:** I*n April, net chemical production of O_3 is in general negative for all the models both in Beijing and Tokyo except for CMAQ 4.7.1 around midday and NAQM in early morning showing slight positive values. I feel the descriptions are not accurate. In April (Fig. 5a,c), both CMAQ5.0.2 and CMAQ 4.7.1 shows substantial positive net chemical production of O3 in Tokyo. Please double check the statement.*

We appreciated the reviewer's check. We made a mistake of Fig. 5(c) and (d) were placed interchanged. Thus, in April in Tokyo net chemical production is negative for all the models.

9) **Line 348-350:** *Since the chemical mechanisms of CMAQ 5.0.2 and CMAQ 4.7.1 are the same, the difference in the model performance must be ascribed to the difference in transport processes. The authors concluded that the chemical mechanism of CMAQ 5.0.2 and CMAQ 4.7.1 are the same, then why is there large differences in the O3 chemical production based on Fig. 5? The section of "Comparison of Chemical Mechanism Sub-Modules" mainly compared the mechanism between SAPRC99 (CMAQ 5.0.2 and CMAQ 4.7.1) and CBM-Z (in NAQM), but discussed relatively little about the chemical production differences between CMAQ 5.0.2 and CMAQ 4.7.1 (Fig. 5). Any explanations?*

Net chemical O_3 production reflects not only chemical reaction mechanism but also concentrations of each relevant compound, which is affected by transport processes as well. Therefore, we think the differences of net chemical O_3 production between CMAQ 5.0.2 and 4.7.1 as shown in Fig. 5 are due to the difference of concentrations of relevant species.

10) **Fig. 2b:** *There is a line with yellow line, which should be the red line. Please double check.*

We appreciated the alert. We modified the Figure.

11) **Line 382:** "*course" should be "coarse"*

We corrected.

12) **Line 383:** *“it would not enough” should be “it would not be enough”*

We corrected.

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