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Geoscientific Model Development Discussions

Interactive comment on "Global high-resolution simulations of tropospheric nitrogen dioxide using CHASER V4.0" *by* Takashi Sekiya et al.

Anonymous Referee #2

Received and published: 28 November 2017

The manuscript 'Global high-resolution simulations of tropospheric nitrogen dioxide using CHASER V4.0' written by Takashi Sekiya presented the evaluation of global chemical transport model of CHASER with different horizontal resolution by comparing to satellite retrieved NO2, aircraft observation campaign, and ozonesonde. Modeling performances were fully investigated on global, regional, and megacity levels. The authors also concluded the potential application of high-resolution modeling for global satellite retrieval and chemical data assimilation. The manuscript includes attractive points to promote our knowledge on high performance computing sciences on the atmospheric chemistry. Although I would like to consider the publication of this manuscript from Geoscientific Model Development, revisions are required. Please see the following comments.

Major comments:

1. Conclusion

Realistically, the computational time is trade-off. What is the authors' conclusion found through this study? On global scale comparison (judged from global RMSE), the authors concluded that 'The improvement when increasing resolution from 1.1° to 0.56° was limited' (P7, L27; Figs. 2-6; Table 1). On megacity levels, the authors concluded that 'These validation results demonstrate the capability of the 0.56° simulation to represent high concentrations over strong local sources' (P11, L25-26; Figs. 7-8). I suppose that these results can be expected one, so what (or which) is the desired resolution at the current computational resources. We do not conduct 2.8° resolution simulation? The conclusion described at Section 6 (P18, L27-31) conveys essential point in this study, so I would like to recommend this including also on Abstract. In Section 5.2, the authors mention the relative computational burden compared to 2.8° resolution simulation. The actual computational time (NOT compared as relative time) might bring us the valuable information.

2. Model evaluation on 2014

In Section 3.3, the authors presented the model evaluation with FRAPPE aircraft measurement. This campaign is conducted on summer 2014 (P6, L29); however, the model simulation was based on 2010 emission intensity (P4, L16-17). The model evaluation should take into account the differences of emission intensity from 2010 to 2014. Detailed and careful discussion and possible differences are needed.

Minor comments:

P1, L2: The expression of 'ranging from 0.56° to 2.8°' impresses the resolution were varied with some intervals; but the simulation was conducted on 2.8°, 1.1°, and 0.56°. Please revise the expression to the correct usage.

P2, L9-31: In this context, 'high resolution' will mean 'high horizontal resolution'. Do

the authors have some suggestion regarding 'vertical resolution'?

P3, L10: Also, the expression of 'Three horizontal resolutions, varying from 2.8° to 0.56°' is ambiguous. Please revise the expression to the correct usage.

P3, L19: What is the update(s) on this version 4.0 of global chemical transport model CHASER?

P4, L17-18; P4, L26-28: GFED version 4.1 provides three-hourly fields, but the authors applied diurnal cycles described here? Why?

P4, L29-30: Did the authors confirm that the application of the diurnal cycles of surface NOx emission can improve the simulation results on 1.1°, and 0.56° resolution?

P5, L3-27: This part includes not 'methodology' but 'results/discussion'. Some parts should be moved to appropriate locations, and reorganized as 'methodology' section. As the discussion of meteorological field, the authors showed the precipitation data with GPCP. I agree that the precipitation is one of the important parameter should be discussed; however, for gas-phase species of NO2 focused in this study, radiation will be more important because the photolysis reaction can determine the NO2 lifetime and NOx cycles. In my opinion, the discussion on meteorology can be only documented, and might not be needed as figure(s)/table(s).

P7, L18: The illustration of these analyzed regions in figure (e.g., on Fig. 2) is helpful.

P11, L28-29: The illustration of the Denver Metropolitan area (DMA) in figure (e.g., on Fig. 7) is helpful.

P12, L16-P13, L4; Figure 11: What observation is used for these probability distributions? Please specify.

P13, L6-7: From Table 2, the analyzed period will be 2008. Please specify the period in the main text.

P14, L5-13: Why the tropospheric NO2 column were shown here? If the authors dis-

cussed the differences in OH and NO2, NO2 should be shown as lowermost five layers partial column as was OH.

P15, L11-12: So updated version 4.0 is not related to the improvement on the chemical kinetics?

P15, L15-16: What means the differences? Anthropogenic amounts from China? What is the analyzed period?

P16, L17-19: Did the authors claim 'high-resolution modeling' on global scales (this will be related to Section 5.3 and 5.4)? In this manuscript, the downscaling approach was not mentioned. If we offer the improvement on megacity levels, the downscaling approach seems to be the alternate way. Especially, NO2 column is strongly related to surface NOx emissions, high-resolution over oceans might not be required (suggested from Fig. 2). Do the authors have some comments?

Figure 10: This figure presented the comparison with observation over the Denver metropolitan area, so please specify the simulation period explicitly.

Figure 12: What makes the OH increment over high altitude over southern hemisphere?

Table 2: These statistical scores averaged over global might be helpful to understand the improvement according to the resolution change. Why so large MB and RMSE are found on 100 hPa comparison?

Technical comments:

Figure 1: The color bars might be understood, but it will be better to fit the corresponded figures.

Figure 2: The color bars might be understood, but it will be better to fit the corresponded figures. Specific indication by using (a) to (h) will be better.

Figure 3 to Figure 6: Specific indication by using (a) to (h) will be better not using

column and row expressions, or remove (a) to (k) because (a) to (k) were not used in the main text (P8, L1-P9, L17)

Figure 7: The color bars might be understood, but it will be better to fit the corresponded figures. Specific indication by using (a) to (h) will be better. The coastline of map in first column should be emphasized to be distinguished. Typo of 'Dever' on (i).

Figure 8: Typo of 'Shengzhen' in the figure.

Figure 9: Specific indication by using (a) to (h) will be better.

Figure 10: Specific indication by using (a) to (j) will be better.

Figure 13: The color bars might be understood, but it will be better to fit the corresponded figures.

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