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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Cloud-scale model intercomparison of chemical constituent transport in deep convection" *by* M. C. Barth et al.

M. C. Barth et al.

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We appreciate the comments given by the reviewer and thank him/her for his/her interest in our paper. In revising the paper, we hope to have highlighted more the comparison between different lightning-NO_x parameterizations and the importance of obtaining a complete dataset for chemical budget analysis. Responses to the specific comments of the referee are given here.

(Specific comments)

1. -It would be one of the challenging tasks to simulate the deep convection cloud requiring high resolution of time and space. However, the worldwidely used community meteorological models such as MM5 or Eta model were not found in this model intercomparison study. The reason should be briefly addressed if any.

We appreciate the referee's point in that widely-used models should be part of this intercomparison. However, the MM5 and Eta models are not appropriate for this intercomparison exercise as their standard versions do not include tracer transport. WRF, which has replaced MM5 and is a widely-used model, is part of the intercomparison exercise. Meso-NH is another widely-used model that is part of the intercomparison exercise.

2. -i.e.,O3(total) = O3(g) + O3(aq) + others, and it should be clarified somewhere in paper that all of chemical species for intercomparison was gas phase.

The results section has been updated to indicate that gas-phase mixing ratios are discussed.

3. -Although this lightening induced NOx emission is likely to be highly variable both temporally and spatially, NOx emission by lightening is an important process in this study but no quantitative rate was addressed. Probably maximum rate or roughly order of magnitude needs to be addressed here.

4. -Page 8040 : Each of the eight models was described but need to be consistent. For example C. Wang model only describes radiation scheme but not found others. At least number of gas or aqueous chemical reactions and species involved in chemical model should be identified for discussion. In table 1, at least horizontal and vertical resolution, horizontal grid structure (i.e., Arakawa-B) need to be summarized to help readers understand for simulation of deep convection.

In response to points 3 and 4, we have revised the model descriptions so that there is more consistency. Included in this revision is the magnitude of NO production per flash.

5. -Caption of Fig.1 c) is confusing. It says that the points are NO mixing ratios and the Lines are NOx mixing ratios. If lines are not initial profile but NOx mixing ratio itself, the levels of NO and NOx are nearly equal, and sometimes NO>NOx in a certain level. Please check.

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Points are observed NO while the line is the NO_x profile to initialize the models. The NO_x profile is estimated from these NO observations. Because NO and NO_2 rapidly come into steady state (within a few time steps), it is not critical to have correct partitioning between NO and NO_2 in the initial profile. The figure caption has been revised to be clearer.

6. Also note the unit of Pmol/mol was indicated in the text, but unit (Nmol/mol) was plotted in Fig. 1c).

This error has been corrected. Thanks for pointing to it.

7. -Fig.11, for WRF-Aqchem, the case without lightening-produced NOx emission was not found in Fig. 11 but discussed in the text.

The case without lightning is not shown in the figure because the results are the same as that with lightning-produced NO_x. We have added “(not shown)" to the text where this is discussed.

(Technical corrections)

-i.e., 3.3 UMd/GCE (A, B, C) should be -> (A, B, and C).

Typographical corrections;

finetedifference ->finite difference

-Cohan et al. ->Cohan et al.(1999)

-Check the unit: designated as (2-s), (2 s) etc.

These corrections have all been implemented.

-P8053: first paragraph: Horizontal resolution vs. contributing to the anvil width: All employed 1km horizontal resolutions except for only Umd/GCE (employed 2 km grid spacing). Therefore probably difference of vertical resolution seemed to contribute more to the difference of soluble species..

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At the end of this paragraph we have also included vertical resolution as a possible reason for affecting anvil size. The horizontal resolution can also affect anvil size (George Bryan, personal communication), thus that reason is retained in the paper.

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