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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Modeling lightning-NO_x chemistry at sub-grid scale in a global chemical transport model" *by* A. Gressent et al.

Anonymous Referee #1

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General Comments

This paper describes the first plume-in-grid parameterization for lightning NOx emissions in a chemical transport model. This has long been a deficiency in CTMs and the development of such a parameterization is of great interest to the modeling community, and therefore I recommend the publication of this paper. The authors thoroughly describe the formulation of the parameterization. The impacts of the plume approach on NOx and O3 concentrations are as expected, and the sensitivity of model parameters is sufficiently examined. I do have a few specific comments/questions that I feel should be addressed in a revised version.

Specific Comments

*P34100 L8-11: Is there a reason that the methods used to determine horizontal dispersion could not be used to find vertical dispersion as well? A greater understanding of vertical dispersion could be used to augment the profiles used to force the vertical distribution of LNOx given by Ott et al. If this is beyond the scope of this study as the authors indicate, that is fine, and a sentence or two explaining why would suffice. Also, is the claim that vertical diffusion is less efficient than horizontal diffusion really true for the strong convective storms that create lightning?

*P34109 L8: I wonder about choosing the 8-11 km range. A brief explanation as to why this range was chosen would be appreciated. Is it appropriate to use the same vertical range for tropical and midlatitude storms, given the differences in their convective depth? How will this affect the parameterization of lightning outside of this range (or, how sensitive are the results to altitude)?

*P34108 L16-: The authors indicate that 3-D turbulence is solved in their parameterization, and give a range of Dh values. More discussion of this would be interesting. How does Dh vary globally? Are there any trends or features in the Dh fields that are of interest? I, and I imagine other readers as well, would be interested in more details on the variability.

*P34110 L25-: The ratio RLNOx is set to be consistent with GEOS-Chem. It's good to be consistent, but I wonder if more can be said regarding this issue since this is a problem that is poorly understood. Is there anything in the parameters used in the new plume-in-grid parameterization that can shed some insight into what drives this difference between midlatitudes and tropics? This is related to my previous comment regarding variability of Dh. More discussion on the spatial variability of the various model parameters may be enlightening.

*Section 4.2: The comparisons between different model simulations (BC, P1, P2 experiments) do not include a direct comparison between the full model with and without the plume parameterization. Section 4.2.2 effectively does this by using the difference

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between P1 and BC experiments, but I found this to be unnecessarily confusing. A separately named direct comparison would be clearer to the reader.

*P34115 L5-6 “an approximate detrainment level (9 km altitude) where the LNOx are most concentrated”: This sentence is a bit unclear. Is this the level where most LNOx is produced, or the level where the detrainment of LNOx from a cloud is the largest?

*Section 4.2.1: The differences in plume lifetime for different seasons and locations are given without context. What drives these differences?

*P34115 L27: Why are some emissions “less important”? Does this just mean there are fewer emissions, or is something making them less important somehow?

*P34116 L5: what do you mean by “tracer is mainly reproduced”?

*P34121 L1 “Significant values of B”: How large does B have to be to be significant? Or does this just mean non-zero?

*Figure 9: The hatched areas are a bit hard to read since they overlap with multiple lines. The authors may want to consider revising this figure to make it more clear.

Smaller technical corrections:

*P34101 L5 “than the surrounding” should be “as the surrounding”

*P34108 L22 “cover all of horizontal” should be either “cover all horizontal” or “cover all of the horizontal”

*P34110 L16,L18 “the northern Colorado” and “the Ontario”. The “the”s should be removed.

*P34111 L 24-25: This sentence is confusing and should probably be re-worded.

*P34121 L8-11: The sentence beginning “That could be explained. . .” is also confusing and needs to be re-worded.

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Interactive Comment