Atmospheric Chemistry and Physics Discussions

Atmos. Chem. Phys. Discuss., referee comment RC1
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Comment on acp-2021-752

Anonymous Referee #1

Referee comment on "Technical note: Entrainment-limited kinetics of bimolecular reactions in clouds" by Christopher D. Holmes, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-752-RC1, 2021

The author has extended an innovative and efficient technique to deal with the "partial cloud" issue, allowing modelers to simulate bimolecular reactions limited by the rate of entrainment. The results suggest that the technique can provide greater accuracy than the current standard, with little implied additional cost.

The central question is both interesting and important, providing an incremental step towards resolving the problem of how to deal with "partial cloudiness" in atmospheric chemistry. The results generally support the conclusions given, although I would like to see some additional information on performance. Although the note does not provide a major advance, the author recognizes the limitations of the technique and does not over-sell the findings. I particularly appreciated the inclusion of Python code to implement the model.

The note is well-structured and compelling. I believe that, with only minor revisions, it is appropriate for publication in ACP. However, I have made some suggestions (and identified one typo) below which I believe could improve the paper.

Major comments

All atmospheric chemistry-transport modeling involves a tradeoff of computational resources against accuracy, so it would be useful if the author provided a sense of what (if any) additional computational burden is caused by the implementation of the exact and approximate entrainment-limited approaches, as well as the thin-cloud or partitioning approaches. This would allow assessment of the true advantage of using this method.

Figure 2 is enlightening, but it would be most helpful if some additional information could be given about how consistent the thin-cloud error is. I would suggest including (around line 112) both the minimum and maximum error of the thin-cloud approximation over the domain; and, if it is ever within 30%, a third row could be included on Figure 2 which shows the error due to the "thin-cloud" approximation. Although the additional three panels are presumably not particularly data-rich, this would help to show whether the benefits inferred from Figure 1 are consistent across all conditions.

The nature of the equations (especially 5 and 7) is concerning with regards to the behavior in the limits of f_c -> 0 and f_c -> 1. In exploring the parameter space for Figure 2, how many points were used? And how were the limits handled? How well behaved is the solution for values of fc which are almost, but not quite, equal to 0 or 1, and how important are these limits? The supplemental material indicates that a there are transitions at $f_c = 10^{-4}$ and $f_c = 0.99$; are these continuous in value? Some discussion of this behavior would be helpful.

Minor comments

Line 42: Typo – "ins" should be "in"