

Dear Authors:

After careful consideration of the Referees' comments and my own evaluation of the manuscript I have come to the conclusion that major revisions to the manuscript are needed before publication in ACP. I do think that there is value in the work and that it could be publishable given the appropriate revisions.

Overall, I agree with the comments from the Referees that there is a mismatch in the approach and the discussion. Given the numerous assumptions regarding the snowpack and its influence on this chemistry (which I agree are necessary given the complexity and the relatively small number of observations), it would be beneficial to consider this work as an idealized representation of the very complex chemistry occurring over Antarctica and to discuss the results in a manner compatible with this idealized approach. There are still many useful insights that we can gain from this work when it takes this view of an idealized approach.

I agree with the Referees that many of the figures showing model-measurement comparison could be/are misleading. I think that these figures, as well as the related discussion would benefit from a revision along the lines of the following comments from Referee #1 that were communicated to me after the submission of the report:

"If the authors were to choose to take the approach of an idealized framework that is designed to test our understanding of nitrate photolysis and its potential impact on certain in snow properties and certain boundary layer properties then they should really move away from comparing with location dependent observations in Antarctica. While on the whole the model does a perhaps adequate job over the entire continent, there are many many discrepancies (and a lack of observations) over large portions. Therefore, a much better approach would be to compare probability distributions of the output of the model to the distribution represented by the observations that are available. This would give a much much better visualization of the comparison than the many geographic plots contained in the manuscript now. SOME of the spatial plots are important since this is a 3-D model after all, but the other reviewer seemed to really take issue with the overplotting of observations (and in some cases they are not even using data but others' calculations of values), and several of the plots are somewhat useless since the extremes dominate on the continent such that one 1 or 2 colors are represented. Plus there's the issue of many observations only being available at certain times of the year. The probability distribution comparison would take care of many of these issues, those that remain can be explained, and it would provide a better framework for developing their take away message. I think that the suggestions above could change the paper demonstrably and make it a much more worthwhile study."

I urge the authors to carefully consider the comments from both Referees. I think that both Referees have provided insightful and thorough comments that, when addressed appropriately, would result in a much improved manuscript. The manuscript would also benefit from a reconsideration of the comments from the first round of reviews. In particular, in the Author Responses to the first round of reviews there are detailed responses to many of the comments raised that are not included in the revised manuscript (as is mentioned by both Referees in the second round).

Please feel free to contact me with any questions.

Sincerely,

Ellie Browne