

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-327

Anonymous Referee #2

Referee comment on "Modeling daytime and nighttime secondary organic aerosol formation via multiphase reactions of biogenic hydrocarbons" by Sanghee Han and Myoseon Jang, Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-327-RC2>, 2022

General Comments

Han et al present a series of experiments conducted in a rooftop chamber examining the oxidation of three biogenic hydrocarbons (isoprene, α -pinene, β -caryophyllene) during both daytime and nighttime conditions. They examine the role of four different oxidants (OH, O₃, NO₃, O(3P)) and a series of environmental conditions, including hydrocarbon to NO_x levels, relative humidity, temperature and particle seed composition.

The major emphasis of the paper is on a gas-particle partitioning model, UNIPAR, that is first fit to the experimental data and then used to make predictions about the variation in SOA yields with different parameters. Major conclusions are that there is a strong positive NO_x dependence to SOA yield during nighttime conditions and a weaker negative NO_x dependence during daytime, and that there is a modest negative temperature dependence.

Overall the paper is in line with other studies of these systems in the recent literature, but offers some new insights based on the explicit gas-particle partitioning model. Some aspects of the presentation should be clarified prior to publication, however, as outlined in the more specific comments below.

Specific Comments

Line 43: Give the total SOA budget for reference. Also add the caveat in this line that these are models of global SOA, and that the cited work is just one of several estimates of this quantity.

Line 54: Not clear what is meant by a sustainable NO_3 radical – perhaps this refers to production of NO_3 radicals being sustained?

Line 58: There are more recent references to the organic nitrate yield from NO_3 + isoprene. See for example:

Brownwood, B., A. Turdziladze, T. Hohaus, R. Wu, T.F. Mentel, P.T.M. Carlsson, E. Tsiligiannis, M. Hallquist, S. Andres, L. Hantschke, D. Reimer, F. Rohrer, R. Tillmann, B. Winter, J. Liebmann, S.S. Brown, A. Kiendler-Scharr, A. Novelli, H. Fuchs, and J.L. Fry, *Gas-Particle Partitioning and SOA Yields of Organonitrate Products from NO_3 -Initiated Oxidation of Isoprene under Varied Chemical Regimes*. ACS Earth and Space Chemistry, 2021. **5**(4): p. 785-800.

Perring, A.E., A. Wisthaler, M. Graus, P.J. Wooldridge, A.L. Lockwood, L.H. Mielke, P.B. Shepson, A. Hansel, and R.C. Cohen, *A product study of the isoprene+ NO_3 reaction*. Atmos. Chem. Phys., 2009. **9**(1): p. 4945-4946.

Line 97: The definitions of high and low NO_x seem arbitrary and as though they might both be high NO_x . Was the fate of RO_2 radicals considered in defining the high and low NO_x conditions – i.e., the rate of $\text{RO}_2 + \text{NO}$ compared to other RO_2 losses?

Line 145: Inclusion of O(3P) is relatively unusual and not normally important in the lower atmosphere (also a conclusion of this study). What motivated the inclusion of this oxidant rather than other minor oxidants such as chlorine radicals or Criegee intermediates?

Line 214: At what rate was N_2O_5 hydrolysis included, and how efficiently does this compete with gas phase NO_3 reactions?

Figure 2: The abbreviations NS, SA, wAS, etc. are not defined in the figure or the caption and not easy to find in the text. Clarify the meaning of these abbreviations in the figure.

Line 230: Conclusion not clear in this sentence. Is this stating that in the presence of aerosol there is no NO_3 reaction with the biogenic hydrocarbons?

Line 248: The biogenic mixing ratios used in the simulations are unrealistically large – does this also bias the SOA yields high?

Line 254: SOA yields from NO_3 said to be low during daytime, but Figure 4 shows them to be larger than OH? Is this correct? The description of isoprene SOA beginning in this line does not appear consistent with what appears in the figure.

Line 279: This paragraph contains a series of qualitative statements about the roles of different mechanistic pathways in forming SOA. Presumably, all of these could be quantified with the model and shown as a figure?

Line 362: What is the chemical composition of gasoline fuel? Presumably this is in the gas phase? Is the high mixing ratio used here realistic to ambient conditions?

Line 403: Suggest removing the reference to “government agency” and referring instead to NO_x control measures.

Line 415: The term “electrolytic” appears out of place here.