

Atmos. Chem. Phys. Discuss., referee comment RC2  
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## Comment on acp-2021-547

Anonymous Referee #2

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Referee comment on "Modeling secondary organic aerosol formation from volatile chemical products" by Elyse A. Pennington et al., Atmos. Chem. Phys. Discuss.,  
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### General comment:

This manuscript evaluates the role of VCPs in SOA formation by conducting CMAQ simulations with new VCP emissions inventory and chemistry. The results show that VCPs are one of the major sources of SOA in urban atmospheres, and they contribute half of anthropogenic SOA in modeled areas. The authors also address the uncertainties and limitations of CMAQ+VCP, illustrating the importance of a better understanding of VCPs. The manuscript is well written, and significant improvements have been made to SOA modeling. I have one major comment about the oxygenated IVOCs.

### Specific comment:

The authors conclude that oxygenated IVOCs VCP precursors have a much smaller role in SOA formation from VCPs. However, this result is inevitable when you think about how the oxygenated IVOCs are treated in the CMAQ+VCP model. The authors use a single surrogate (SOAOXY) to represent the oxygenated IVOCs. It undergoes a one-step reaction with the hydroxyl radical to form a nonvolatile aerosol surrogate (AOIVOC). While the SOA yield for the oxygenated IVOCs ranges from 0.06 to 0.6, the lowest value was used for the SOA parameterization. I understand the challenges in modeling the oxygenated IVOCs in CMAQ, but it's not proper to have the statement that oxygenated IVOCs make fewer SOA from VCPs while the mechanisms of these compounds are not well-represented.

### Technical corrections:

P3, L70: "...SOA yields were reported under unrealistic atmospheric conditions", please add refs.

P3, L80: The abbreviation "CMAQ" has been introduced earlier in line 55.

P4, L103: "...volatility(C\*)", please provide a more accurate definition of C\*.

P4, L110: Cater, 2010 is cited here. Is it relevant?

P5, L120~134: SAPRC07TIC\_AE7I\_VCP assignment rules are described quite well in the SI, but they are unclear to me in the main manuscript.

P7, L183: Please indicate the source of the SOA yield data in Figure S1.

P7, L185: The model species listed in Table 1 are unclear to me. Even though these species, such as SILOX and SOAOXY, are included in the SOA chemistry, they undergo gas-phase reactions. Is that correct?

P7, L189: "...(SVSILOX2/ASILOX2J)", I only see ASILOX2 in the table, not ASILOX2J.

P7, L191: "...(SVSILOX1/ASILOX1J)", I only see ASILOX1 in the table, not ASILOX1J.

P9, L235: In line 174, it said SOAOXY undergoes a one-step reaction with OH to form AOIVOC. However, SOAOXY is missing in Figure 1.

P11, L295: VCPs are predicted to be a larger source of IVOCs than mobile sources. Can it be quantified?

P14, L400: "...emissions and chemistry updates were approximately 5 times more effective than enhanced oxidant levels from VCPs in increasing SOA". I think this statement needs more discussion.

P15, L419: "...Our results indicate", what results? Can you be more specific? In which figure or which table?

P15, L431: If SOA yield for the asphalt emissions can exceed 10% (the bias of SOA in CMQA+VCP is below 10%), will the SOA yield be over-predicted once this source is added to the model?

P17, L475~P18, L500: A few assumptions are made in these several paragraphs, but they are overturned immedicably by the authors. For example (line 477): "...which could result in a dilution effect matching the temperature dependence seen in Figure 5a. However, the predicted CO bias does not depend on temperature, which implies that modeled PBL height is not an important driver of the SOA bias temperature-dependence." I found this type of sentence is very confusing and suggest the authors rewrite these paragraphs.