Editor's comment

Thank you very much for addressing most of the reviewer's comments, the manuscript is greatly improved. After minor revisions regarding previous referee comments, I am happy to accept the manuscript for publication.

We would like to thank the editor for your time and thoughtful comments on this manuscript. Your comments are repeated below followed by our response to each comment.

Referee #3 - Similarly, the abstract is very long-winded and makes it hard to understand the science question that the authors are trying to answer. I recommend revising the abstract to focus more on the big picture impact of this work rather than a list of detailed conclusions.
Response: The abstract has been revised based on the referee's comment.
Review by Editor: The track-changes file shows hardly any changes to the abstract, please address the reviewer's comment.
Response to Editor: To make the abstract clear, some sentences were modified, removed, or added in the revised manuscript. Changes are marked as red in the manuscript.

Referee #3 - Line 149: Can you give quantitative descriptions for the reactivity scale?
Response: We reported the mathematical description of model parameters including reactivity scales and physicochemical parameters, and mathematical equations for stoichiometric coefficients in the recently published paper by Yu et al (Supporting Information of ACP, 2022). In this manuscript, same reactivity scale has been used, and the physicochemical parameters and mathematical equations for stoichiometric coefficients are extended to biogenic HCs at four major oxidation paths to simulate day and night SOA mass as seen in Sect. S7.
Review by Editor: Please provide a reference to Yu et al. around line 149.
Response to Editor: The reference has been added in the revised manuscript.

Referee #3 - Section 3.4 and Figure 1: I'm confused by which parts of the model mechanism uses MCM gas phase chemistry and which parts use SAPRC chemistry. Please clarify.
Response: Please find the response to comment 7. The model parameters and the predetermined mathematical equations for stoichiometric coefficients for lumping bins were derived by using the product predicted from the semi-explicit mechanisms for the atmospheric oxidation of biogenic HCs. The model parameter and the equations are integrated to the predicted hydrocarbon consumption from any gas mechanisms. In order to support SOA formation in complex ambient air, model parameters and equations for stoichiometric coefficients were integrated with SAPRC07TC. The hydrocarbon consumption predicted with both semi-explicit mechanisms and SAPRC07TC well accords with that observed in chamber studies.
Review by Editor: I would like to reiterate on referee #3's question. When was MCM used and when was SAPRC used? Please refer to any previously published work here when determination of mathematical equations for stoichiometric coefficients for lumping bins was performed for a previous study and please outline the exact methodology (incl. showing calculation results) when it was newly performed for this study.

Response to Editor: The MCM mechanisms and additional explicit mechanisms are simulated to produce explicit products. The resulting products are classified into lumping species bins based on volatility-reactivity. These gas mechanisms are also simulated to build the model equations for lumping species' stoichiometric coefficients as a function of HC ppbC/NOx ppb ratios (ranging from 1 to 50) and gas products' aging, and yield lumping species' physicochemical parameters that are used to process multiphase partitioning and in-particle phase reaction. The resulting model parameters and pre-determined equations

can be applied to any gas mechanisms, which can predict the consumption of hydrocarbons and the production of RO_2 and HO_2 at given NOx levels. Thus, the UNIPAR model can be suitable to be simulated even in regional models that generally use Carbon Bond mechanisms or SAPRAC. In our study, the UNIPAR model was coupled with SAPRC07TC to perform the prediction of SOA formation.