

***Interactive comment on “The roles of volatile organic compound deposition and oxidation mechanisms in determining secondary organic aerosol production: A global perspective using the UKCA chemistry-climate model (vn8.4)” by Jamie M. Kelly et al.***

**Anonymous Referee #2**

Received and published: 19 November 2018

This work by Kelly et al. investigate the impacts of VOC deposition and oxidation mechanisms on SOA formation within the United Kingdom Chemistry and Aerosol (UKCA) model. This work evaluated simulated OA/SOA with surface and aircraft observed data in different areas around the globe. This work highlights the uncertainties in the global SOA budget associated with the changes in SOA schemes. I will suggest to accept this manuscript after minor revisions. My specific comments are listed below.

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(1) Emissions. How may VOC from biomass burning and anthropogenic sources respectively? Are both VOCBB and VOCANT are assumed to emit from the surface? The biomass burning source could be elevate emissions and might be impact on some of the results in this study. For example, in page 21, “ At higher levels, NO/HO<sub>2</sub> reduces, suggesting an increasing importance of the HO<sub>2</sub> pathway at higher altitudes. However, due to the fast chemical reactivity, the majority of SOA production occurs at the surface. For the majority of the atmosphere, the difference in the magnitudes of the oxidant concentrations favours the RO<sub>2</sub> +NO pathway over the RO<sub>2</sub> +HO<sub>2</sub> pathway.” Therefore, if the SOA production occurs in higher altitude because of elevate emissions, more SOA will produce through HO<sub>2</sub>.

(2) Default Treatment of SOA. The SOG condenses irreversibly to form SOA in UKCA. Will it lead to a different result if the model assumes the SOG condenses reversibly to form SOA?

(3) Could author discuss about the potential impacts of the precursors deposition on SOA production associated with different source types?

(4) Page 8 Line 27: “All carbonaceous primary emissions are emitted into the insoluble mode and transferred into the insoluble” I cannot understand this sentence.

(5) Page 12 Line 15-20. “Consequently, a stoichiometric yield of 66 % corresponds to a mass yield of 100%. Therefore, 66% is the highest stoichiometric yield that ensures conservation of mass without the addition of other atoms, such as oxygen.” Why the mass conservation used here?

(6) Page 14. Line 20. “all VOC source ranging from 47 to 74 Tg (SOA) a<sup>-1</sup>” change to “47 to 75”?

(7) Page 15. Line 17-20. What is the lifetime of SOA in this study?

(8) Page 15. Line 30. How model predicted SOA compare to the observations? Do they use monthly averaged or median values? Since “1.875° longitude by 1.25° latitude” in

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this study is a really coarse resolution, will the comparison with remote sites seems better?

(9) Page 19. Line 25-30. “ these changes in annual-total VOCANT/BB oxidation rates within emissions source regions correspond to reductions between 10 and 30 % (not shown). By contrast, downwind of many emissions source regions, the lower reactivity acts to enhance VOCANT/BB oxidation rates.” It is really hard for me to find the downwind emission source regions because the largest increase occurs in source regions such as China and East US. Could the author give a map plot to point out where these downwind regions are?

(10) Page 26. Line 5-10. “ Although the global annual-total SOA production rates are identical, the global annual-average SOA burden is 10 % greater when using benzene as the parent VOC undergoing multi-generational oxidation, highlighting the strong spatial gradients in SOA lifetime.” Could author explain how the SOA lifetime changes?

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2018-142>, 2018.

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