

## ***Interactive comment on “Sensitivity of organic aerosol simulation scheme on biogenic organic aerosol concentrations in climate projections” by Arineh Cholakian et al.***

**Anonymous Referee #1**

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The paper investigates three aspects of biogenic SOA 1) impact of climate change 2) sensitivity to SOA formation scheme. 3) regional differences, in particular effects over Mediterranean sea. Although the first question has been addressed before, the combination with assessment with different SOA formation schemes and the huge sensitivities to them that were found make the paper interesting. The applied methods are sound and the outcomes are interpreted well.

The fact that several aspects are addressed makes it however more difficult to present the results. This is already reflected in the title, which tries to summarize this but is difficult to understand and not completely correct. The order of presenting the

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results could also be improved, e.g. present figure 6 earlier in the manuscript to give the reader an idea of the gradients and order of magnitude, and going into validations and more detailed analyses. Also, since absolute concentrations are rather different for the three schemes, comparing relative differences is on the one hand a respected method, but one should be careful especially when concentrations are low and small absolute differences are exaggerated. Structure of section 4 is not consistent with subchapters: would be easier for the reader to present section 4.3 after presentation of Europe and Mediterranean. Sometimes the authors should be more precise. Below, detailed comments on the various parts of the paper will be given. The motivation to focus on the summer and on biogenic SOA is there but could also be made a bit more prominent. Detailed comments

L1 Organic aerosol (OA)...introduce abbreviation here.

L6 The differences between three different schemes to simulate OA are explored. These schemes are... 1) a molecular scheme, 2) a standard ...

L12 These changes are largest over the summer period...

L17: Absolute concentrations are different: move this sentence to l 10, before addressing the relative change, also quantify (molecular scheme gives twice as much OA as VBS scheme)

P2 l 8 e.g. temperature change, land use changes and CO2 inhibition (Heald..)

P2 l 19 BVOC emissions have been quantified...mainly to assess the future evolution of... Statement that it is only emerging does not reflect the date of the papers cited, and they are of the same period as the Arneth paper.

P3 l 10 Impact of climate change is different per region since emissions and atmospheric composition are different per region, and depend on sensitivity of scheme to temperature changes. The description of the thermodynamics are different between the scheme. The current sentence is not precise and confusing

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P4I6 More information on the modelling framework in the current study is provided in..

P5 I2: the domain covers latitudes 30-70°N and longitudes 40W-60E

P5 I 32: What about the performance of SOA2p in the Mediterranean, as compared to SOAvbs and SOAmod?

Figure 2:averaged pver 70 years of RCP scenarios (2031-2100) and averaged over 30 years for historic simulations. A-c mentioned in text, not indicated in figure

P6: I10. For the perspective it would be good to mention that winter OA concentrations in cold episodes are higher than summer OA concentrations (Table 3)

P7 I25-26: would be better to stick to SOAvbs and SOAmod convention as defined on p 5. Differences in correlation are small.

Table in figure 3 is nearly unreadable, shoud be put as a text table outside the figure for readability. Also fonts of figure tick labels too small.

P8 I9 : change quite a bit: be more precise

P8 I 11 annual average “historical”..., annual average historical .... Unit is per cm2 I assume, this is not what it states. Correct woud be molecules cm-2 yr-1.

P8 I17-20: Leave out sentence : for the Mediterranean region, there are no local emissions. .... The following sentence is more clear by itself.

Fig 4 Quality of graphics is poor, tick labels unreadable, too small

P9I3 Important sentence, could be combined with your reference to Cholakian (2019) in the section on choice of years, and maybe included in the introduction, depending on how you see this as a motivation and how this is the result of the present study. Would help the reader to get this statement very clear in an earlier part of the paper.

P10 I3 The statement can be related to seasonality in biogenic emissions.

P10 I16: What do yo mean by distribution of origins and volatility bin aspects?

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P11 I8: relative contribution of HOA becomes less, since in your scenario you did not change anthropogenic emissions, but more BSOA is formed.

P12 Fig 6: State in caption that these are summer averages.

P12 I8 The maximum change is found in the summer period, reaching a maximum of ... These large differences are for areas with very low concentrations, so the small increase in absolute numbers is blown up. A few words should be devoted to this aspect, to indicate where the most relevant increases are found. Although Baltic sea and North Sea are identified as region with larges changes, I think that the relevance is larger for central Europe where a small relative increase implies substantially higher absolute SOA concentrations. When you put section 4.3 after section 4.4 you could easily include the Mediterranean as a focus area in this discussion and make it the ultimate summary.

P13 I 15-18: Part on PM10 not relevant for this paper

P13 I 27 : difference, not change

P14: Figure 7: differnences between dots and squares only visible when enlarging on computer screen, not when one prints the paper.

P14 section 5: In climate projections, not only the temperature changes but also the circulation patterns (and even differently for different global climate models). This might be the reason for the different directions in the lines for the two periods. Also, when looking at a smaller domain, this change in circulation may become more relevant instead of averaging it out over a large domain. In particular over the Mediterranean without sources of isoprene/terpenes, changes in transport patterns are important.

P15 I 4 correpsondence of what to what?

P16 Conclusionss: reasoning could be slightly more precise. Your results show that BSOA changes due to climate change are highly sensitive to the SOA scheme used, and that none of th BSOA schemes here matches the observations, which shows the

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importance of further development of more accurate SOA schemes. When the SOA scheme is truly accurate, a good temperature dependence would be implicit, since you would like to use it over cold areas like Scandinavia as well as warmer areas like the Mediterranean.

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