

In this paper, Couvidat and Sartelet present a new flexible model which is based on the molecular surrogate approach and describes the organic aerosol formation in different phases (aqueous and/or organic) following different approaches (equilibrium and/or dynamic). This module is a great addition to the organic aerosol modeling field and is of definite interest to the GMD audience. I have found the scientific methodology valid and after addressing the comments of the two previous referees, the model now is described adequately as well. However, I have several major comments and some more minor that are listed below. I would recommend publication only if these comments are addressed.

Major comments:

1. Section 2.1 Overview: In this section the authors should thoroughly describe the processes contained in the new model. On the contrary, they keep comparing their model with other models throughout the section. This makes it difficult for the reader to follow what are the exact processes included in SOAP if he/she is not well aware of the processes contained in the other models as well. I recommend including three main parts on this section. The first part (couple of paragraphs) should be self contained and describe the processes included in SOAP without referring to any other models. In the second part (one paragraph) they should make a quick comparison with the processes included (or not included) in the other models as well. They should also add one last paragraph (third part) where they can highlight the novel aspects of SOAP.
2. Section 2.2.2 Page 9: SOAP assumes that the total (organic and inorganic) amount of water computed by SOAP should be at least equal to the amount of water given by ISORROPIA. However, as they mention later, organic species can enhance or reduce the water absorption by aerosols. Wouldn't it be more valid to just accept the water content calculated by SOAP (even if it's lower from ISORROPIA's) as ISORROPIA is called prior to SOAP and does not include organics? Moreover, they should include a small discussion about the major differences on the parameterizations used by ISORROPIA and SOAP to compute water. It is not very clear why it is scientifically valid to accept the SOAP calculations when the water content is larger than ISORROPIA's but to accept the ISORROPIA calculations when it is not. Please discuss the rationale behind this assumption.
3. Section 2.2.4: An explanation of how the exact compound concentrations in the different organic aerosol phases are determined is missing. Are the components first condensed in the organic phase and then are separated in more than one phases (using some kind of factors?) or the phase separation is performed in prior and the components are condensed on the different phases (using equations 14-24 with more than just one $A_{p,i}$)? Moreover, what exactly are the differences between the several organic phases?

4. Section 3.3 Page 32 first paragraph: I do not agree with the use of value 0.5 for the accommodation coefficient. It is well known that for accommodation coefficients between 0.1 and 1, the mass transfer rate is high and not sensitive to the exact value used. The authors have to use a lower value, certainly lower than 0.01, to limit the effect of mass transfer to the organic phase. You can refer to Figure 12.13 of Pandis and Seinfeld (2006) for choosing the appropriate α value that will allow you to test the effect of diffusion in the organic phase.
5. Section 3 Results: The authors should add an evaluation of the model by comparing the model results against measurements from the period covered by their test cases. There is no way to prove the credibility of their model if they will not evaluate it. If measurements are not available, they have to compare it at least against a more comprehensive dynamical model (i.e., KM-GAP). They mention on the conclusion section that they will do this on a future study but the evaluation is certainly needed at this point, either against measurements (preferred) or at least against other models.

Minor comments

1. Throughout the manuscript the authors are using the organic phase either on singular form (i.e., diffusion in the organic phase) or on plural form (i.e., condense into the organic phases). You have to be consistent throughout the text, so my recommendation would be to use the plural form since the model can have more than one organic phases and use the single form only in cases you have only one organic phase (i.e., specifically in section 2.2.1 and 2.2.2, or on some results for the POA and SOA compounds)
2. Page 4 line 22: Can you add the threshold used for humidity below which condensation to aqueous phase is not allowed?
3. Page 5 lines 1-2: Can you add all the new processes added in SOAP and not just an example?
4. Page 5 line 17: Difference from what? See also the first major comment where I suggest adding the comparison of SOAP process with other models in a separate paragraph.
5. Pages 5 line 28 to page 6 line 2: Are there any maximum values of bins, phases, and layers that the user is allowed to distribute the organic compounds? How do these numbers affect the overall performance of the model? Are there any recommended (optimal) values to be used as default?
6. Page 6 lines 7 and 8: Please change the “gas phase and an organic phase” into “gas and organic phases”

7. Page 13 lines 7-17: This paragraph is confusing. It is not clear in which parts the authors discuss about the processes contained on their model or processes that are well known but are omitted from their model. Please rephrase the whole paragraph
8. Table 4: There is no information, anywhere in the manuscript, about what these compound names stand for. You should include a description of them somewhere in the text or in this table.
9. Figures 1-3 and Tables 1-4 are not referred in the text at all.

Typos:

1. Page 2 line 15: Add "(OA)" after "organic aerosol"
2. Page 2 line 17: Erase "(OA)" after "aerosol"
3. Page 2 line 23: Rephrase "preliminary" with "the results of this study"
4. Page 3 line 8: Add "(3D)" after "three dimensional"
5. Page 3 line 18: Replace "organic aerosol" with "OA"
6. Page 4 lines 3-4: A verb is missing from the sentence
7. Page 4 line 11: Add a comma after "air quality models"
8. Page 4 line 16-17: Please change the last sentence to "This paper describes the SOAP model and the results of several test cases"
9. Page 4 line 18: You may want to replace "development" with "description"
10. Page 5 line 26: Erase the comma and add "in order" before the "to be used" and replace "in" with "by"
11. Page 6 line 6: Change the "are now described" with "are described below"
12. Page 9 line 2: Add "(i.e., ISORROPIA)" after the "inorganic model"
13. Page 9 line 2: Add Replace "for the inputs of" with "as input to"
14. Page 9 line 3: Erase "(for example ISORROPIA)"
15. Page 24 lines 2-3: Erase the "partially by" before the "aqueous phase"
16. Page 25 line 11: Add "interface" before the "layer"
17. Page 25 line 12: Replace "are" with "remain"
18. Page 29 lines 14-16: Replace "tables 5 and 6 show respectively with and without the ideality assumption the concentrations of organic aerosol for both test cases formed from the various precursors as well as the concentrations of water." with "tables 5 and 6 show the concentrations of organic aerosol for both test cases formed from the various precursors as well as the concentrations of water, with and without the ideality assumption, respectively."
19. Page 29 line 16: Erase the word "here"
20. Page 29 lines 26-27: Move the "in the biogenic case" in line 27 after the "their concentrations" in line 26

21. Page 30 line 5: Replace “result of previous study (Couvidat et al., 2012)” with “results of Couvidat et al. (2012)”
22. Page 30 line 14: Erase “of” after “change”
23. Page 30 line 27: Replace comma with “and” after the “BiA2D”
24. Page 32 line 14: Replace “much slower to reach equilibrium” with “reaching equilibrium much slower”
25. Figure 3: An output arrow is missing
26. Figures 4-7: Replace “equal to tenth the concentrations” with “equal to one tenth of the concentrations”
27. Table 8: Replace “saturation” with “separation” on the titles of second and third columns