

Interactive comment on “The co-condensation of semi-volatile organics into multiple aerosol particle modes” by Matthew Crooks et al.

Matthew Crooks et al.

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1. "My main criticism is related to examples and discussion presented in Chapter 7. After reading the manuscript the main question is if the parameterization is good enough in representing dynamic conditions so that it can be used in atmospheric applications? It is difficult to understand what is done in Chapter 7. What the modelling setup described at lines 390-394 actually mean? Does it mean that for the first 300 or 10 seconds the condensation is only allowed for the second mode and after that also for the first mode? Maybe more discussion motivating the modelling setup is needed to make it easier to understand. One way to estimate if equilibrium approximation gives reasonable results in atmospheric conditions would be to run the parcel model with varying temperature and relative humidity trajectories mimicking the turnover of boundary layer."

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Multiple mode equilibrium partitioning is designed for multiple monodisperse modes. The aim of the Chapter 7 was to investigate how well the theory works if you use log-normal size distributions with effective Kelvin terms (using the median diameter). The reason we allowed condensation to occur only on the larger particles initially was to speed up the equilibration process to allow us to compare the how well equilibrium partitioning theory can deal with the lognormal size distributions rather than this mimicking the lifetime of aerosol particles and SVOCs in the atmosphere.

In order to address this issue we have added a specific section 7.2 to show the existing results and have tried to clarify the purpose of the section more clearly. Section 7.3 has additionally been added to compare how the equilibrium model compares to the parcel model when all particles and SVOCs are allowed to interact simultaneously from the being of the simulation.

2. "I think it is quite uncommon to use R_H notation for saturation ratio. I would recommend changing it to S in equations as it is commonly used and because you are also discussing RH as relative humidity, which is usually expressed in percentage."

" R_H " changed to " S " where appropriate.

3. "Line 49: Citation to Connolly et al. (2014) might be in a wrong place. At least I cannot find relevant discussion on aerosol forcing from that article."

Citation removed

4. "Line 70: Why is Hildemann et al. (1991) article cited when discussing on the current status of knowledge on atmospheric organic components. Has there been any progress since 1991?"

Citation updated

5. "At least for me, the "Quasi-leading order solution" is a totally new term for describing the solution. Why "quasi"?"

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“Leading order” has a precise mathematical definition which is slightly different from what we have used, hence the “quasi” in front. However, given the readership of GMD it is probably over pedantic to add the “quasi” so we have removed it.

6. "Figure 3: How many solutions there is actually presented?"

50: previously it stated 30 but there are actually 50.

7. "Figure 9: Diameters are really confusing as they are different than given in the Table 4 and in the text."

We think they are the same. Table 4 shows the range of values used in Figures 9-11 and Figure 9 shows only some of these values. Is the confusion that the title contains the diameter of the first mode? ie “ $d_1 = 50 \text{ nm}$ ”. This is necessary to distinguish between the two sets of results, one with a small mode of diameter 50nm and the other with a small mode diameter of 100 nm. It was a little confusing in the right two plots for this to follow on from the words “second mode” so we have added brackets around the “ $d_1 = 50 \text{ nm}$ ”. We have also changed the upper case notation for diameter to a lower case to be consistent with the rest of the text. The number concentration is now explicitly written in the figure caption too.

8. "Figure 13: It looks like the system is not evolving towards equilibrium conditions. Why not?"

It is not evolving towards to equilibrium. This section was intended to compare how well equilibrium partitioning (designed for monodisperse modes) could cope with each mode being a lognormal size distribution. It turns out that there can be discrepancies for size distributions with median diameters of less than about 50nm. This is discussed further in the response to the first comment.

9. "Figure 15: The change in the shape of aerosol size distribution in numerical solution is strange. Is there some reason why larger particles grow more so that the shape of distribution is not preserved?"

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We presume you mean the linear section to the right of the size distribution. This is a result of using a bin structure with the same number of particles in each bin. At large sizes you can end up with a very wide bin and that linear section is simply Matlab joining two data points by a straight line. The size distribution plots have been re-done with 140 size bins in response to the first comment, which has resolved this issue.

Please also note the supplement to this comment:

<http://www.geosci-model-dev-discuss.net/gmd-2015-187/gmd-2015-187-AC1-supplement.pdf>

Interactive comment on Geosci. Model Dev. Discuss., doi:10.5194/gmd-2015-187, 2016.

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