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Geoscientific Model Development Discussions

GMDD

Interactive comment

Interactive comment on "A parameterisation for the co-condensation of semi-volatile organics into multiple aerosol particle modes" *by* Matthew Crooks et al.

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Author Responses to Reviewer 1

1. Indeed, the amount of and rate of condensation of both water and the SVOCs is influenced by the size of the particles and their composition. This effect, however, is highly non-linear and unlikely to ever be accurately represented in a computationally efficient parameterisation. Our approach is to derive a model for the dynamic condensation of SVOCs near cloud base that assumes a quasi-constant composition. The aerosol particle size distribution that is used in the activation scheme of Fountoukis and Nenes, however, does take into account both the resulting change in size and chemical com-

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position that this condensation of SVOCs induces. We use a mass averaged approach (using the condensed masses from the DCP) to calculate the change in chemical composition. Therefore, we appreciate that our parameterisation is an approximation but we do believe that changes in chemical composition have been included in the CCN activation process to an effective degree.

With regards to changes in surface tension, this is an active area of research and not a factor that definitively should be included in such models. Again, our approach is an approximation and some details must always be neglected in order to derive computationally efficient models.

An ideal parameterisation would take into account, for example, the geometric standard deviation of a lognormally distributed size distribution of particles, however, we have chosen to use an "effective" diameter in our calculations. We have chosen to use the median diameter in this setting to calculate the total condensed mass of SVOCs on a particular particle mode. This mass is, however, distributed between different sizes of particles based on their geometric standard deviation. The method of doing this is given in Connolly et al. (2014) and assumes a constant arithmetic standard deviation but varies (reduces) the geometric standard deviation while conserving mass (involatile plus SVOCs). The result is a narrower size distribution at cloud base that is then inserted into the activation scheme of Fountoukis and Nenes. Consequently, we do believe that we have made use of the particular particle size distribution through changes in the geometric standard deviation.

Line 25: corrected Line 50: We really meant just those based on the Fountoukis and Nenes with its later derivatives using a similar approach. We have modified the sentence to account for this. Line 120: words removed Line 156: word "dry" added Line 409 and Figure 6: We disagree, the parcel model results are higher than the parameterisation in Figure 6 Figures 3-7. We feel that adding a legend would actually clutter the graphs especially as there is no concise way of describing some of the models. As there are multiple similar figures that all use the same colour of line for each model we think that an initial investment of time to understand the first graph will allow all subsequent graphs to be understood.

Author Responses to Reviewer 2

Yes, the Kelvin term distinguishes the equilibrium from the saturation partial pressure.

1. N should be number concentration and has been updated. 2. By initial, we mean the state at which the cloud activation scheme of Fountoukis and Nenes is implemented. This will depend on the specific large-scale model used and as such we have kept it in the general setting. An explanation of this has been inserted at line 168. 3. The justification for neglecting the equilibrium partial pressure is explained in detail in Section 2.1. 4. Section 2.3: The use of the phrase "dummy index" means that the index k doesn't mean anything physically and is used only in the summation. Unlike, I that refers to a specific particle mode and j that refers to a specific volatility bin. In equation 9, the use of the index k in the summation is, indeed, redundant but in equation 10 there is both a particular volatility bin with index j and a summation over all volatility bins and we feel that the use of k is important here. There are, indeed, typos in equation 10 that have been corrected and hopefully resolve the issue.

Page 1, line 9: corrected Page 6, lines 1,2: The use of "high RH" is deliberately vague as this is an assumption made in the model and it is difficult to quantify for a general case. Instead, we make an assumption and compare the results on CCN concentration of making such an assumption. The use of "it" has been clarified. Page 6, line 156: word "dry" added Eq. 20: The geometric standard deviation of the aerosol size distribution at cloud base (including SVOCs) is different to that of the involatile particles. That is why there are multiple subscripts in order to distinguish them. The use of $\ln\sigma$ is notational and refers in its entirety to the geometric standard deviation. We do not, in fact, calculate exponentials of logs. Page 12, lines 326,327: We have added "in a dynamic model" to clarify this. But we mean the condensed mass doesn't change much between an RH of 90% and 91% but changes a lot between 99% and 100%. Page 12, line 331: corrected Page 13, line 335: correct to “involatile particle mode” Page 18, line 433: corrected Page 18, line 441: corrected Page 20, line 475: “as” changed to “at” Page 28, line 696: corrected

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