

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

**Anonymous Referee #2**

Received and published: 6 November 2017

### **1 Recommendation**

The authors develop a new parameterisation for cloud droplet activation that takes into account condensation of SVOCs on the aerosol and works for multiple modes. The derivation of the parameterisation is explained with some detail (but can be improved, see Major points), and the new parameterisation is thoroughly tested by comparing its results with results from a parcel model. The paper should be published after a couple of improvements and corrections that can easily be achieved.

C1

### **2 Major points**

Section 2.1: What is the difference between "equilibrium partial pressure" and "saturation partial pressure"? Is it the Kelvin factor? Another similar expression is "equilibrium saturation ratio". This is puzzling. Please clarify.

Section 2.2:

- 1) It took me quite a while to understand the derivations in this section. First, equation 1 is a bit hard to understand unless one knows that  $y_i$  is the condensed mass of a *single particle* per unit mass of air. It is also a bit puzzling that while everything else is "per unit mass of air",  $N$  is simply the number of particles. Although checking the units in eqs. 1 and 4 confirms that  $N$  is indeed a simple number, I feel uncertain what to choose for  $N$  in a concrete case. At least in your examples you use it as per cubic centimetre. I think it would be more natural to let  $N$  be the number of particles per unit mass of air (or unit volume) and  $y$  simply the condensed mass of a particle.
- 2) What in these derivations do you mean exactly with "initial"? Is this a more or less randomly chosen initial state or something fixed? The equations show that results depend on the initial state. Thus it seems important to know how it is chosen.
- 3) It should be explained why the equilibrium partial pressure can be neglected in the derivation of eq. 5.

Section 2.3: I was quite confused by your use of the "dummy index". This is not necessary at all and the sentence after eq. 9 should be deleted. Eq. 9 would have the same meaning with the summation over  $j$  instead of  $k$ . The confusion is increased by two typos in equations 9 and 10 where instead of  $y_{ij}^0$  I think it should be  $y_{ik}^0$  under the sum over index  $k$ .

C2

### 3 Minor points

Page 1, line 9: check unit! I assume that instead of  $\mu\text{g}^{-3}$   $\mu\text{g m}^{-3}$  is meant.

Page 6, lines 1,2: The sentence beginning with "At the high..." is unclear. What is the "it" in "... and reduces it..."? Please reformulate.

Page 6, line 156: better define  $D_d$  as "dry diameter", to distinguish it from later uses of "diameter".

Eq. 20 and equations in A1 and A2: while these equations are correct their form is unnecessarily complicated. Why don't you just write

$$SD = D_m \sqrt{\sigma} \sqrt{(\ln \sigma - 1)}$$

in Eq. 20 instead of the complicated expressions involving exponential functions and logarithms? I assume that in your code you do not compute the exp of logs since that would take unnecessary CPU time.

Page 12, lines 326,327: I don't know what you mean here. Is RH your initial RH so that problems occur when your initial RH is too close to 100%? Otherwise, approaching cloud base you will always end up with RH near 100%.

Page 12, line 331: form  $\rightarrow$  from.

Page 13, line 335: "is the same as the ammonium sulphate modes". Which ammonium sulphate modes? It seems here to me as if I had missed something before, but the ammonium sulphate appears here for the first time.

Page 18, line 433: delete "a" before "carbonaceous".

Page 18, line 441: I assume you mean hydrophobic here (last word in the line).

Page 20, line 475: as  $\rightarrow$  at (90%...).

Page 28, line 696: delete the dot before the comma.

C3

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Interactive comment on Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2017-123>, 2017.