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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Atmospheric new particle formation: real and apparent growth of neutral and charged particles" *by* J. Leppä et al.

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The manuscript is generally well written and contains important and comprehensive new results. The derived analytic formulae will be useful for future growth rate analysis of new particle formation events in the atmosphere. I recommend the article to be published after my comments have been considered by the authors.

I can find several good motivations to why you have developed the analytical formulae to estimate the growth rates. However you don't clearly mention them in the paper. I think you could advertise your article in a better way. What will you use the analytic formulae for in the future and why are they important?

1. The introduction is well written. However, partly I still miss the answer to why it is

important to derive simple analytical formulae to estimate the growth rate of a nucleation mode due to self-coagulation and the apparent growth rate due to coagulation scavenging by larger particles. I think that one of the main motivations is that it is important to be able to clearly specify the condensation growth rate due to condensing vapors from measurements of the particle number size distribution in the atmosphere and not just the apparent growth rates. In section 4 you describe that this is important for correct estimates of the concentrations of condensable vapors. I think you should include this information in the introduction too, and clearly write that this is one of the motivations why you have derived the analytic formulas for self-coagulation and coagulation scavenging. Another important motivation could be that the analytic formulas can be used to estimate the importance of the charge enhancement on the growth rate in the atmosphere.

2. Section 2 "Tools and methods" was interesting to read and it is relatively easy to follow the derivation of the simplified analytic equations which are tested against the detailed aerosol dynamic model results. I have no other general comments on this section.

3. Figure 5. I don't understand why you use condensation sink as a proxy for the coagulation sink and not the actual coagulation sink. You write that you use the condensation sink as it is diameter independent. Don't you want to illustrate the diameter dependence of the coagulation scavenging which is caused by the fact that the coagulation sink depends on the diameter of the particles? Could you clarify this to me?

4. Section 3.3.3 "Semi-apparent growth due to self-coagulation". First I did not understand that by self-coagulation you mean the coagulation between all the particle sizes within the nucleation mode and not just the coagulation between particles within the same size bin. If self-coagulation would be considered only between particles with exactly the same size (same size bin) there would not be any semi-apparent growth due to self-coagulation. Please clearly state what you exactly mean with self-coagulation in the beginning of the text. I did not find this information.

5. Section 3.4 “Charges”. Interesting results and discussion but it is much information and you need considerable amount of time to understand what Fig 6 shows. Are the red dashed lines in Fig 6 displaying the atmospheric most realistic conditions? It could be good to give this information. That all formed particles should be charged (50/50) seems unrealistic for atmospheric conditions, or am I wrong? Can the fractions of charged particles change significantly from time to time and from one location to another, and could this then explain observed variability of the growth rate? I understand that these questions cannot be answered within the scope of this article but it would be interesting if you could address these questions in the future. Since the analytic formulae provide the tools to answer these questions you could mention this as a motivation of why you derived these formulas.

6. I understand that the Ion-UHMA model simulations are important to test the simple analytic formulas for self-coagulation and coagulation scavenging, since this information cannot be derived from measurements. However, otherwise I don’t really see why the simplified analytic formulas should be applied to model simulations which already contain the information about the concentrations of condensable vapors, coagulation sink etc. Hence, I don’t know if the text on line 19-27 on page 2105 is relevant or not. Do you mean that one important application of the simplified analytic formulas is to address the influence of the fixed sectional approach and the numerical diffusion on the model results? Then I think this should be clearly stated here. For complex conditions observed in the atmosphere with influence from coagulation, condensation and new particle formation at the same time I can understand that this method could be valuable to test the model performance, concerning the numerical diffusion. I thought that the model simulations were used mainly to test the analytic formulae and that the main application of the analytic formulae is for measurement data. If this is the case I think you should reformulate the last sentence in the abstract.

Specific comments:

Line 10 in abstract. Try to avid to use the phrase “work quite well” since this information

is subjective.

Page 2083, line 2-11. I think you should clearly write that the constant growth rate you talk about is for non-volatile compounds only. I assume that the reason why you see an increase in the condensational growth rate as a function of particle diameter from measurements is that the much of the condensing material is semi-volatile.

Figure text to Fig. 6. A fraction cannot be larger than 1. Either you should change the legend of the figure or in the text to percent instead of fraction.

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