Atmos. Chem. Phys. Discuss., 7, S3247–S3252, 2007
www.atmos-chem-phys-discuss.net/7/S3247/2007/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "On the contribution of Aitken mode particles to cloud droplet populations at continental background areas – a parametric sensitivity study" *by* T. Anttila and V.-M. Kerminen

T. Anttila and V.-M. Kerminen

Received and published: 19 July 2007

Response to Anonymous Referee #1

We thank the referee for his/her constructive comments. The remarks made are addressed below.

General comments

Comment - p. 6078, l. 17: replace 'chemistry' by 'chemical composition'

Author comment - We now use the term 'chemical composition' in the manuscript.

Comment -The last sentence of the abstract is redundant (see lines 7-10)

Author comment - The redundancy has been omitted from the abstract.

Comment - p. 6079, l. 13: What is the upper limit of the particles considered?

Author comment - Regarding the Aitken mode, it has been already stated in the Introduction that the mean mode diameter lies typically between 50 and 100 nm in diameter. Regarding continental aerosol populations as whole, the important size range for cloud formation is roughly below 0.5 μm in diameter.

The latter upper limit is not important for the purposes of the manuscript, and the considered range of the mean mode sizes of the Aitken mode will become clear later on. Therefore these limits are not explicitly mentioned in the Introduction.

Comment - p. 6080, l. 23: What are typical time scales for growth of newly formed particles into Aitken size particles?

Author comment - The typical growth rates of newly formed particles are around 1-10 nm/h at continental background areas, translating to growth timescales of 5-50 h when using 50 nm in diameter as a lower limit for the Aitken mode. We now mention these timescales in the Introduction.

Comment - p. 6081, l. 5: Here, and in the remainder of the manuscript: I would prefer to call it a ‘variability in the input parameters’ rather than ‘uncertainty’ in the input parameters as indeed atmospheric particles (populations) exhibit these properties. Use of the term ‘uncertainty’ in this context implies that the measurements of these properties are associated with large errors.

Author comment - We now use the term ‘variability’ instead of ‘uncertainty’ consistently through the manuscript.

Comment - p. 6086, l. 22: Internal or external mixtures imply that there are (at least) two different aerosol compounds. You should point out that your assumption of an internal mixture is only of importance for using ’epsilon’ as for all other properties you assume one single solute anyhow (as you state earlier).

ACPD

7, S3247–S3252, 2007

Author comment - We now motivate the discussion regarding the mixing state by stating that: “The issue [mixing state] is relevant since the water solubility of the particle matter is modeled here with more than one component by dividing the particle dry mass into soluble and insoluble fractions.”

Comment - p. 6086, l. 25: Replace ‘Solubility’ by ‘water-soluble mass fraction’ to be consistent with Table 1.

Author comment- The manuscript has been updated accordingly.

Comment - p. 6089, l. 8: Obviously, the numerical approach chosen here cannot account for a concentration-dependent surface tension, as you point out. However, this flaw in the numerical treatment leads to a significant overestimate of the surface tension effect as the Kelvin term only determines drop formation close to activation when the particle size, and thus, dilution increases rapidly (Ervens et al., 2005). It should be emphasized more clearly in the manuscript that the importance of the surface tension as shown here should be considered as an upper limit.

Author comment - When discussing about the numerical treatment of the surface tension in the model, we now state that “Because particles dilute rapidly during cloud formation, the surface tension of particles and droplets approaches that of water as the cloud develops. Consequently, the assumption regarding constancy of σs overestimates the effect of organics to the particle/droplet surface tension to some extent.”.

We mention this issue again in the “Discussion and Conclusions” section when discussing about the results.

Comment - p. 6089, l. 14: Also the mass accommodation coefficient is a concentration-dependent value (e.g., Feingold and Chuang, J. Atmos. Sci., 2002). Thus, any conclusions that are drawn on the importance of the mass accommodation coefficient also represent an upper limit. This fact should be made clear as well throughout the manuscript.

ACPD

7, S3247–S3252, 2007

Author comment - We now state in Section 2.3 that “It should be further noted that the value of α is kept constant in a similar manner [than σs] even though it is expected to depend on the particle/droplet size and composition (e.g. Feingold and Chuang, 2002). As in the case of the surface tension, the estimated importance of α represents consequently an upper limit.”

We mention this issue again in the “Discussion and Conclusions” section when discussing about the results.

Comment - p. 6093, l. 27: It is not surprising that the parameters ’epsilon’ and MWavg show similar importance when varied over a similar range. According to Köhler equation, they determine the number of solute moles (Raoult term). A brief comment on this numerical relationship would be helpful.

Author comment - We added an explanation “The result that ε and MWavg have similar importance is intuitive since both of them are varied over a factor of four to a good approximation (Table 2) and the number of dissolved molecules, which determines the Raoult term in the Koehler equation, scales with these two parameters (Seinfeld and Pandis, 1998).”

Comment - p. 6095, l. 4: Replace ‘solubility’ by ‘water-soluble mass fraction’.

Author comment - The manuscript has been updated accordingly.

Comment - l. 6096, l. 17: Add here something like (...the number concentration of cloud droplets [...]) ‘as a function of updraft velocity’.

Author comment - The manuscript has been updated as suggested.

Technical comments

Comment - p. 6080, l. 5 Rissman

Comment - p. 6082, l. 25 one order of magnitude

ACPD

7, S3247–S3252, 2007

Author comment - These two mistakes have been corrected.

Comment - p. 6083, Eq.-1 Should the first symbol on the right hand side be the variable introduced before ? (check lower/upper case Greek symbol)

Author comment- There was actually a typing error which is now corrected.

Comment - p. 6083, l. 7: Table 2 is cited before Table 1

Author comment - The order of Tables 1 and 2 has been switched.

Comment - p. 6085, l. 28: ...particles that are able to ...

Comment - p. 6086, l. 13: belonging to the first group

Comment - p. 6086, l. 26: Switch ‘MWavg’ and ‘rho’

Author comment - The manuscript has been updated according to the three remarks above.

Comment - p. 6088, l. 5/7: In Table 1, minimum value is 0.25.

Author comment - There were typing errors in the text, the correct minimum value is 0.25. The mistakes have been corrected.

Comment - p. 6090, l. 9: 0.12, 0.16, 0.28 %

Comment - p. 6092, l. 2: Remove ‘as’

Comment - p. 6092,. l. 18: Replace ‘what’ by ‘when’

Comment - p. 6105 Add ‘m/s’ to Table header

Author comment - The manuscript has been updated according to the four remarks above.

Comment - p. 6108: The quality of Figure 2 is poor. At least the legends should be enlarged.

ACPD

7, S3247–S3252, 2007

Author comment - We will make sure that the quality of the figure does not suffer in the publication process, and the legends have also been enlarged.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 6077, 2007.