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Atmospheric
Chemistry
and Physics
Discussions

Interactive comment on “ Seasonal variation of CCN concentrations and aerosol activation properties in boreal forest” *by* S.-L. Sihto et al.

Anonymous Referee #1

Received and published: 29 November 2010

The authors present measurements of cloud condensation nuclei (CCN) in a boreal forest, near Hyytiälä, Finland. They determine the activation size threshold of the particle by two ways, i.e. by determining the fraction of particles that activate and based on measurements of the hygroscopic growth factor at a relative humidity (RH) = 90%. They find reasonably good agreement between these two methods. The extensive data set, acquired over a year of measurements, allows investigating the seasonality of CCN activation parameters (fraction, critical diameter, hygroscopicity) but results show quite consistent average monthly values. However, significant differences are seen during new particle formation events. The main results of the study are the facts (i) that – on average – CCN hygroscopicity can be described by kappa = 0.18 which

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is in agreement with previously determined kappa for mixed SOA/inorganic particles, (ii) new particle formation events change the fraction of activated particles due to the formation of many small particles and (iii) growth of newly formed particles into CCN sizes occurs over the span of a day. These results are useful and should be highlighted more clearly throughout the manuscript. I recommend publication after consideration of my additional comments below.

General comments

- The analysis of both CCN and growth factor data relies on the fact that all particles are internally mixed. Are there composition and mixing state measurements in similar locations available that support this assumption? The width of the measured growth factor distribution might give a hint of the mixing state of particles. Can this be quantified?

- The fact that the same critical diameter is derived based on growth factors and CCn measurements suggests that the hygroscopicity ('kappa') is constant over the RH range of 90% to supersaturated conditions. Usually, kappa derived from CCN measurements are higher than those derived at lower RH since either organics dissolve if more water is available and/or inorganic compounds further dissociate (e.g., Petters and Kreidenweis, 2007).

- Is anything known of the composition (hygroscopicity) of newly formed particles? Can an ageing time scale' be given of these particles until they exhibit the same hygroscopic properties as larger, older particles?

Specific comments

p.28232, l. 5: Define 'DMA'

p.28232, l. 5: replace 'cloud droplet activation' by CCN activation' as 'cloud droplets' implies that a dynamic system exists and not equilibrium conditions.

p. 28233, l. 29: Define 'aerosol activation quantities'

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p. 28234, l. 4: add year of experiments (and remove in Section 4.1.)

p. 28236, l. 7-10: What are the size ranges and size cuts for ‘large’ and small’ particles?

p. 28237, l. 12: Are there studies that show that surface tension of organics can be neglected? If so, they should be cited here.

p. 28237, l. 16: The Köhler equation also includes an osmotic factor (phi) that takes into account the activity of the solutes. The product of phi and number of ions for ammonium sulfate is usually smaller than 3 (Low, 1969).

p. 28240, l. 24: Add reference for the analysis of different air masses.

p. 28244,l. 26: kappa = 0.6 for ammonium sulfate is certainly at the upper end of determined values (as it assumed full dissociation). How would the results shift if smaller values (e.g., 0.53 (Petters and Kreidenweis, 2007)) are applied?

p. 28245, l. 9: The density of organics is usually around $\sim$1.4 g cm-3. Thus, the conversion from mass into volume fractions would even yield smaller mass fractions.

p. 28245, l. 29: based on Figure 9, that the critical diameters of S = 0.4% and S= 0.6% seem nicely to encompass the value of 70 nm, and not only being ‘broadly consistent’. It might be useful to give average values here for the critical diameters at these two S.

p. 28253, l. 8: Both Figure 2 and Figure 3 do not show a ‘significant’ change in critical diameter. The day-to-day variability (Fig. 3) seems much more significant than the variation in the averaged values.

Figure 5: Increase symbol size and connect legend to caption (what is meant by ‘min’, ‘max’, ‘mean’?)

Figure 6: Add, a, b, c, d, to the figures and use in text.

Technical comments

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p. 28233, l. 29/30: change word order: ‘how are CCN concentrations affected. . .’

p. 28235, l. 21: DMA has been defined before

p. 28235, l. 24: Define ‘DMPS’ (and remove definition a few lines later)

p. 28235, l. 26: Introduce ‘RH’ here

p. 28236, l. 3: add ‘a’ (in a size range. . .)

p. 28240,l. 3: Replace ‘kappa’ by Greek letter.

p. 28240,l. 19: add ‘a’ (. . . to be a larger difference. . .)

p. 28246,l. 5: Add ‘the’ (in the atmosphere)

p. 28247,l. 9: replace ‘inside’ by ‘during’

p. 28248,l. 18: replace ‘??A1’ by ‘A1’

p. 28248,l. 24: Use NPF instead of ‘new particle formation’

p. 28250,l. l. 17: replace ‘less big’ by ‘smaller’

p. 28252, l. 26: ‘campaign’

Table 1: Footnote is redundant

Figure 1, caption: Replace ‘with’ by ‘at’ (. . .at five water supersaturations)

References

Low, R. D. H.: A Generalized Equation for the Solution Effect in Droplet Growth, J. Atmos. Sci. , 26, 608-611, 1969.

Petters, M. D., and Kreidenweis, S. M.: A single parameter representation of hygroscopic growth and cloud condensation nuclei, Atmos. Chem. Phys., 7, 1961-1971, 2007.

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