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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Measured and modelled cloud condensation nuclei concentration at the high alpine site Jungfraujoch" *by* Z. Jurányi et al.

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The authors are thankful for the comments and suggestions made by Anonymous Referee #3. Restructuring the manuscript made it much better readable.

Comment:

While reading the paper I had the impression that not all the information about one issue (e.g., AMS derived _) can be found at one place of the text. I rather had to scroll up and down and dig up the pieces to fully understand your results. (You will find some of these cases in the specific comments.) I think that it would help the readers to structure your paper more clearly for example by adding subsections to Sect. 2. Another improvement (but this might be only a personal preference) would be

to merge the Results and the Discussion section into one section, and then divide this into several subsections.

Response:

Thank you especially for this comment, it helped us to substantially improve the readability of our manuscript. The "results" and "discussions" are now merged together and divided into 8 subsections.

Specific comments:

Comment:

From which measurement results or references do you derive the mass absorption efficiency of 6.6 m2 g−1? Please explain where this value comes from.

Response:

A reference for the mass absorption efficiency is now provided. The exact value is rather uncritical because the BC mass fraction is very low at the JFJ.

Comment:

It would be illustrative to show your calibration line (SS vs. dT) in a figure.

Response:

The linear calibration curve fits the calibration points well and the calibration remained constant during the measurement campaign. For this reason we only added the equation of the calibration line to the text.

Comment:

As far as I know, NaCl is known to have a kappa value of 1.28 (Petters and Kreidenweis, 2007). In your statement, however, it sounds as if the kappa of NaCl is 1.4. Please correct that accordingly.

Response:

The value of 1.4 corresponds to a NaCl particle at RH=94% and a dry diameter of 100 nm. The kappa value at the point of activation is indeed lower and it depends on dry size. The text has been corrected: “The kappa values of ambient aerosol compounds vary between 0 (insoluble, wettable) and $\sim$1.2-1.33 (pure NaCl).”

Comment:

It would be helpful to add also a statement how you calculate the volume fractions in order to obtain kappa with Eq. (3). It is mentioned only in the next section but would be good to know already at this point.

Response:

This equation has been added.

Comment:

Since you are showing the results of the AMS data here it might be good to mention already here that you did not observe a size-dependent particle composition.

Response:

Added sentence: “No substantial size dependence composition was observed in the time-averaged AMS data (see also Sect. 4.2)”

Comment:

Maybe you should mention the campaign average kappa value at this point. You need that value later in the Discussions for your sensitivity analysis (p. 8874, l. 7 ff) but do not mention it anywhere.

Response:

We added the campaign mean kappa value and some interpretation: “The campaign mean AMS/MAAP derived kappa value was 0.34. This value is well representative for

the global mean kappa values for continental regions (0.27$\pm$0.21) whereas the mean value for marine regions is much higher (0.72$\pm$0.24; Andreae and Rosenfeld , 2008; Pringle et al. , 2010).”

Comment:

I do not find that the three differently derived kappa look similar to each other (kappa_AMS is much higher than the other two kappa almost at all times; kappa_CCNC and kappa_HTDMA are sometimes close to each other, sometimes not; even the trends of the three kappas are not always similar, especially in the beginning of the measurement period). You should specify the similarities/differences a bit.

Response:

This paragraph has been rewritten, thereby emphasizing that the differences between the different kappas do not cause substantial differences in CCN prediction: “. . .Even if there is sometimes a significant difference between the CCNC (brown dotted line) and the AMS/MAAP (black line) derived kappa values, the closure comparing the measured and calculated CCN concentration worked almost perfectly. This is because the calculated CCN concentration is relatively insensitive to the changes in the chemical composition as it was shown before (Section 4.6). HTDMA and CCNC derived kappa values correlate well at most times and their overall agreement is better than the agreement between AMS/MAAP and CCNC derived kappa values. Therefore even better agreement between CCN measurement and prediction is obtained if the size distribution data are combined with the HTDMA derived hygroscopicity parameter for the CCN prediction.”

Comment:

As I wrote already above, you are discussing the CCN predictions here using a constant average kappa, but you have not mentioned the average value so far.

Response:

Done. See answer to previous comment.

Comment:

You should include the results of the CCN prediction using the HTDMA derived kappa (figure or text) to prove this statement. I am wondering if this CCN prediction would be as good as using the AMS derived kappa. Fig. 6 shows that there are sometimes large differences between kappa_AMS and kappa_HTDMA (e.g. more than 100% on 20.5.). From Fig. 8 one can see that this difference would result in a 40% different CCN concentration.

Response:

The referee is right, there are sometimes noticeable differences between the kappa values derived from the HTDMA, AMS and CCNC/SMPS measurements. kappa_AMS is often larger than kappa_CCNC and therefore the slope of the correlation between predicted (from AMS and SMPS) and measured (CCNC) CCN concentration is slightly larger than unity (i.e. 1.045 at this SS; see Table 3). It can be seen from Fig. 9 that most of the time the agreement between kappa_HTDMA and kappa_CCNC is better than between kappa_AMS and kappa_CCNC (except for 09/05/2008). For this reason the CCN prediction using the kappa_HTDMA is even slightly closer to the measurement than the prediction using kappa_AMS. Presenting the closure as a comparison of different kappa values or a correlation between measured and predicted CCN concentrations is essentially equivalent. We have chosen the latter option for presenting our composition/CCN closure results, because CCN concentration is the main quantity of interest. The former option has been chosen on purpose for the discussion of using HTDMA data instead of AMS data, because it emphasizes the differences between the different kappas. These differences are not noticeable between different CCN predictions because the latter are rather insensitive to changes in kappa. The new subsection 4.7 contains now the following paragraphs: “Even if there is sometimes a significant difference between the CCNC (brown dotted line) and the AMS/MAAP (black line) derived

kappa values, the closure comparing the measured and calculated CCN concentration worked almost perfectly. This is because the calculated CCN concentration is relatively insensitive to the changes in the chemical composition (kappa values) as it was shown before (Section 4.6). HTDMA and CCNC derived kappa values correlate well at most times and their overall agreement is better than the agreement between AMS/MAAP and CCNC derived kappa values. Therefore even better agreement between CCN measurement and prediction is expected if the size distribution data are combined with the HTDMA derived hygroscopicity parameter.”

Comment:

A logarithmic scale for the particle diameter might be better as usually used for this kind of plot.

Response:

Done.

Comment:

You should mention in the caption that the CCN concentrations were predicted using AMS in these plots.

Response:

Done.

Comment:

Why does the x-axis not start with 1 May like in the other figures? For better comparability it would be good to have consistent axes for the time.

Response:

There is no CCN data available before 6th of May, therefore the calculation of CCNerror is also impossible. Nevertheless, the time axis has been changed to be consistent with

Figures 1-3.

Comment:

Why are the plotted lines not symmetric for a negative and a positive deltakappa (e.g., for a positive deltakappa the difference between predicted and measured CCN concentration is larger for SS=0.47% than for SS=0.59%, but for a negative deltakappa it is smaller for SS=0.47% than for SS=0.59%)? Is this plot showing the sensitivity as an average over the whole campaign?

Response:

Yes, Figure 9. shows the sensitivity averaged over the whole campaign. This information has been added to the text. The following paragraph has been added to subsection 4.6: "A priori one would expect a symmetric order of the sensitivity curves at different SS for positive and negative deltakappa, i.e. the curves shown in Fig. 9 are expected to cross each other at deltakappa=0 and nowhere else. This is the case for most pairs of sensitivity curves. However, the sensitivity to kappa for nearby supersaturations (e.g. SS=0.59% and SS=0.47%) is very similar such that experimental uncertainties can explain deviations from the expected symmetry, always bearing in mind that these sensitivity curves are based on experimental size distribution and CCN data acquired at slightly different times for different SS."

Technical corrections: Everything has been adapted.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 8859, 2010.