Atmos. Chem. Phys. Discuss., 10, C3409–C3415, 2010
www.atmos-chem-phys-discuss.net/10/C3409/2010/

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.

Anonymous Referee #1

Received and published: 31 May 2010

The paper of Juranyi et al. presents a closure study between measured and predicted CCN number concentrations. CCN predictions were done by feeding a simplified Köhler theory with measured number size distributions and bulk chemical compositions data sampled over a one month period at the high alpine site Jungfraujoch by using a suite of aerosol instruments.
The authors show that (i) knowing the mean chemical composition of the aerosol suffices for a reliable CCN prediction, but (ii) more detailed information on the aerosol size distribution is needed to achieve a good prediction of the CCN number.
To this end, detailed sensitivity studies on the influence of aerosol chemical composition on the CCN prediction are performed and also some analysis on the consequences of changes of the the aerosol size distribution on the CCN number. A good overview on the 'state of the art' in the CCN research field is also given in the

paper.

However, I have some general and a couple of specific comments (listed below) that may help to further improve the manuscript. Altogether, I recommend the paper for publication in ACP after considering these comments.

General comments:

1. The point that the aerosols chemical composition does not greatly influence the CCN prediction -that means that it does not influence CCN number!- is discussed in detail in the paper, but in my view the point that particle size does matter is considered too short.
   I recommend to extend the discussion of the influence of particle size on CCN number and to include it in the conclusions and also in the abstract.

2. A closer comparison of this work with e.g. Dusek et al., 2006 (and others) should be given in the paper. It would be good to see how the mean aerosol chemical composition of the two measuring sites differ? And is there already an idea of the range of mean κ for different regions? Is this range larger or smaller than the $\Delta\kappa$ range tolerable for a reliable CCN number prediction (Fig. 9)?

3. I also recommend some revision of the style of the paper (see also specific comments):

   - Please give more information about your study (see for example specific comments 2 and 6, etc.).
   - An explanation of what is presented in the beginning of a paragraph/section instead of at the end would lead to a more fluent understanding of the paper (see for example specific comment 15).
   - Introducing subsections for the discussion of different points surely would give the paper a clearer structure.

- In section 4 (Results) the observations are mostly only described, interpretation is missing.

Specific comments:

Comments are sorted in the order of appearance in the manuscript.

1 Introduction

1. **P 8861, line 6**: The paragraph should better start with the second sentence:

   'The critical supersaturation (SScrit), defined as the supersaturation (SS) at which the cloud droplet activation will take place, is mainly determined by the diameter of the particle at the point of the activation. The activation diameter depends on... (Köhler, 1936).'

   Proceed now with the first sentence, here it makes more sense:

   'CCN activation is hindered for smaller particles, since the equilibrium vapour pressure over a curved pure water surface is elevated. The process of activation can also be influenced ...'

2. **P 8864, line 5-8**:

   'Here we present for the first time a CCN closure study covering a wide range of SS (0.12%-1.18%) from a remote continental measurement site which is most of the time situated in the free troposphere and only sometimes influenced by injections from the planetary boundary layer (Nyeki et al., 1998).'

   After the long, nice introduction the description of your work is rather short and I think doesn't represent your work properly. Please extend the description of what you have done and give an outlook what is new and exciting here! This is the

   point where you either make your readers curious to continue with reading or put away your paper.

3. **P 8864, line 25**: A short description of the total aerosol inlet should be given here. The inlet is important enough, but one doesn't want to search/read another paper only to have an impression on it.

2 Method

4. I suggest to add table summarizing the instrumentation, otherwise it is hard to keep in mind which information is available when reading the results.

3 Theory

5. **P 8868, line 4**: Please add a reference for the Köhler theory.

6. **P 8868, line 9**: *'... in our calculations, ...'*

   What calculations? To understand the other sections it is important to know what you have done in the calculations. See also comment 2!

   I strongly suggest to start the theory section with explaining the purpose of your calculations and which parameters are derived from measurements and which one are calculated.

   P 8869, line 4: This paragraph should be integrated in an explanation at the beginning of the section.

4 Results

7. **P 8869 , line 27**: *'Two distinct synoptic conditions were encountered during the measurement period.'*

Here, the information is missing that you start now to describe your own measurements. I suggest a new paragraph starting for example:

'Thus, for our closure experiment we performed measurements of xyz (describe the aerosol properties you measured) throughout May 2008. Time series of our measurements are shown in Figures 1-3. '

Now you can continue with 'Two distinct synoptic conditions ...'.

8. **P 8870, lines 11-15**:

   Even if *' a smaller part of it (AF) can be attributed to variations of the aerosol properties such as shape of the size distribution and chemical composition.'*, it can be seen from Fig. 1 that AF does correlate with the number of CCN: a higher AF is seen during the more polluted boundary layer period than for cleaner free tropospheric conditions. That means that a 'polluted' aerosol population has more hygroscopic or larger particles in general compared to clean conditions.

   If the particles would be more hygroscopic, then there should be a correlation of AF with GF and κ, respectively. If they are larger, the mean size should correlate with AF. From Fig. 2 one can see that AF correlates with particle size, from Fig. 6 no good correlation of AF with κ can be seen $\rightarrow$ size matters more than chemistry?

   Please discuss and explain that.

   Later: in the paper (see Discussion, P 8874, paragraph before last line) this is discussed. Please find a 'closure' in the paper!

9. **P 8870, lines 16-28**: contains a description, but no interpretation of the aerosol number size distribution (Figure 2b), namely that the 'polluted' aerosol population show a larger mean size compared to clean conditions.

10. **P 8871, first paragraph**: Figure 3b is not discussed.

11. **P 8871, second paragraph**: contains a description, but no interpretation of Figure 3c and 3d.

12. **P 8872, line 8**: What is the finding of Lance et al. (2009)?

13. **P 8872, line 12-13**: *'... number size distribution and chemical composition are more stable ...'*

    More stable than where? Better say only stable.

14. **P 8872, line 15-18**:

    ' In addition the assumption of size-independent chemical composition may become invalid (Ervens et al., 2009) and a substantial fraction of externally mixed particles with very low kappa values may be present.'

    How does this argument supports the good CCN prediction? Please explain in more detail.

15. **P 8872, lines 19-25**: The paragraph becomes clearer if you start the paragraph with the last sentence:

    'Another result of our closure study is that from the observations there is no indication for a suppressed surface tension of the aerosol.

16. **P 8872-73, last/first paragraph**: Again an introductory sentence on what will be discussed next and why it is important is missing and it doesn't become clear while further reading, except that differently derived κ are compared. I suggest to rewrite this paragraph.

5 Discussion

17. **P 8873, first paragraph**: Again an introductory sentence on what will be discussed next and why it is important is missing ...

18. **P 8873-8874, last/first paragraph**: It is not clear what this paragraph tries to tell the reader ...

19. **P 8874, paragraph before last line**: see comment 8.

20. **P 8876, line 9**: Explain again SDE.

Figures

Figure 1-3: Please enlarge the captions of the axis and legend.

Figure 2: Panels 2a and 2b are referred in the text, please introduce them also in the Figure.

Figure 9: No reference of Fig. 9 in the text, I suspect that on p 8875, l 25: Fig. 8 should be Fig. 9.

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