Atmos. Chem. Phys. Discuss., 6, S898–S901, 2006
www.atmos-chem-phys-discuss.net/6/S898/2006/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical note: Characterization of a static thermal-gradient CCN counter" *by* G. P. Frank et al.

G. P. Frank et al.

Received and published: 18 May 2006

Response to the general comments of Referee #1:

First, we would like to thank the referee for many valuable comments that indeed will lead to an improved manuscript. However, we don't agree with the referee that the paper is only interesting to the degree that it increases our understanding of the performance of the static diffusion chamber cloud condensation nuclei (SDC CCN) counter. Descriptions and discussions leading to improved calibration techniques are also of importance. This perhaps does not improve the understanding of the performance, but it improves the performance itself, and improved performance leads to more accurate measurements.

The paper was not meant to be a research article with a general investigation of SDC

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CCN counters, but a technical note describing the Mainz SDC CCN counter (with camera and image analysis detection), discuss limitations and errors of SDC CCN counters, and describe and discuss the used calibration technique in more detail than normally can be found in the recent literature. The overall purpose is to improve the accuracy of the CCN measurements, and we believe that our findings are of interest to other users of CCN counters, and perhaps also to users of CCN data. Thorough characterisation is important for all CCN counters, but unfortunately one can find many examples in the literature where this has either not been done or not properly documented. The findings in our paper make it clear that commonly made assumptions and shortcuts lead to serious errors in CCN measurements. The paper is meant to present and discuss characterisation methods in more detail, and point to possible and needed improvements of previously used methods. In some cases this also leads to improved understanding of the performance of SDC CCN counters. The more detailed description has not only been welcomed by Referee #2, but already proven to be very useful as a reference for experiments and discussions involving multiple groups with CCN counter experience.

Most of the recent publications presenting CCN counters or CCN data, describe only briefly the characterisation methods and the limitations and errors of the instruments, as part of the methods and techniques section of a research article. In addition, only few SDC CCN counters with modern camera detection technique exist, and since this technique has several advantages over the light scattering detection technique, we believe a more detailed description would be of general interest. We are only aware of the two existing instrument versions, the one described by Giebl et al. (2002) and the commercial CCN counter M1 from DH Associates (for which we have not been able to find a detailed description in the literature). The description and discussion in the present paper would most likely be too extensive to fit into a conventional research article presenting measurement results.

Examples of what we mean with detailed descriptions and discussions of the calibration method are the way how to fit curves, the detailed error analyses, pointing to the

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need of calibrating the number concentration as a function of supersaturation, and discussions about how to calculate the theoretical critical supersaturation with the Köhler equation. The latter can lead to large uncertainties, depending on which assumptions that are made when using the Köhler equation, and this is indeed an issue of an ongoing investigation by our and other groups, to further improve the instrument performance.

We agree with the referee that conclusions 2 and 3 are adding new knowledge and better understanding about SDC CCN counters. However, we don't agree that the evidence presented is insufficient. Figures 5 and 6 very well show the dependence of the calibrated sensing volume on the supersaturation. We agree that Figure 5 can be improved by presenting the data points, and we will do so. The discussion can perhaps also be improved, but otherwise the experimental evidence is very compelling to us, and we cannot see how it would be insufficient.

The evidence for conclusion 3 is perhaps more limited, but we state only that we did not observe any detectable supersaturation depletion for the CCN concentrations and supersaturation studied. We also see no reasons to investigate the effect at lower supersaturations, since the droplet growth is slower at lower supersaturations. If the water vapour depletion can be neglected at 0.7% it can also be neglected at lower supersaturations, especially since we chose our particle size such that the difference between particle Sc and instrument S (the driving force for particle growth) is large in our experiment. It might be interesting to investigate the effect at slightly higher CCN concentrations, but since the coincidence effects anyway make it difficult to measure at much higher concentrations, that would probably be of limited interest. However, we agree that it would be beneficial to extend the investigation to higher supersaturations and perhaps to higher concentrations, and this is possible to do if the editor requires so. However, we would prefer to leave this to future investigations, by us or other CCN counter users.

Finally, we would like to mention that we appreciate several of the specific comments,

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for example the comments about the difficulty to distinguish between water vapour depletion effects and coincidence effects, the dependence of CCN growth on composition, and the request of further discussion of the large difference between the observed and nominal supersaturation. The growth dependence on composition and the effect on the measured number concentration lead to larger measurements uncertainties, and is indeed a limitation of SDC CCN counters. Referee #2 also has made similar comments. These effects are interesting and will be discussed more in the revised version of the manuscript and in answers to the specific comments.

Interactive comment on Atmos. Chem. Phys. Discuss., 6, 2151, 2006.