Atmospheric Chemistry and Physics Discussions

Interactive Comment

Interactive comment on **"Calibration and measurement uncertainties of a continuous-flow cloud condensation nuclei counter (DMT-CCNC): CCN activation of ammonium sulfate and sodium chloride aerosol particles in theory and experiment"** *by* D. Rose et al.

Anonymous Referee #3

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The authors present calibration data for the DMT cloud condensation nucleus instrument. These data are analyzed to determine the precision and accuracy of the calibration. Using several different formulations of Köhler theory the authors evaluate the uncertainty of the accuracy. They report inconsistent supersaturations obtained from calibrations with sodium chloride and ammonium sulfate, which likely result from differences in water activity vs. composition relationships used to calculate the instrument

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supersaturation from the particle dry diameter. The manuscript also discusses the dependency of calibrated supersaturation on instrument operating conditions (i.e., inlet temperature, sample flow rate, sample pressure, and streamwise temperature gradient). Results from these measurements are compared to calculations from a fluid dynamics model.

The manuscript is well written and highly relevant to the readers of ACP. The experimental maps of operating conditions vs. calibrated supersaturation are novel and I recommend that the manuscript is published after the following comments are addressed.

The authors determine the effective water vapor supersaturation (S_{eff}) in the CCNC by taking the temperature difference $\Delta T = T_3 - T_1$. These values are used to interpret the calibration data throughout the paper (Figures 2, 4, 5, 6, 7, 8, and 11). In our DMT instrument the temperature gradients $\Delta T_a = T_2 - T_1$ and $\Delta T_b = T_3 - T_2$ are set to different values by the manufacturer with $\Delta T_a > \Delta T_b$. This is done so slight fluctuations of supersaturation in lower section do not lead to secondary activation. It is important to note that $\Delta T \neq \Delta T_a \neq \Delta T_b$. The internal instrument calibration parameters are based on ΔT and it is unclear how the instrument internally converts ΔT to ΔT_a, although the result is accessible in the data files. While this detail is of minor importance to the operation of the instrument, it does affect all theoretical calculations that relate the streamwise gradient to an instrument supersaturation. Both the Roberts and Nenes (2005) and Lance et al. (2006) model are based on a single ΔT, i.e. it is assumed that the second temperature controller has no effect on the thermal profile. If it is true that $\Delta T \neq \Delta T_a \neq \Delta T_b$ for your instrument, then the model calculations must compared to ΔT_a instead of ΔT.

The above point may help explain why the thermal resistance values are a function of ΔT (Figure 5). This behavior is unphysical pointing to an inconsistency between the model and the calibration.

It appears that the measurements shown in Figure 2a are not normalized to unity. This

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will introduce some bias in the fit toward smaller values of D_{50} and hence a bias in the calibrated supersaturation.

If the linear fit shown in Figure 2b is used to convert ΔT to S_{eff} then several percent bias in supersaturation will result, particularly at high values of ΔT. This adds to the uncertainty stemming from Köhler theory and should be discussed in the text.

References

Lance, S., J. Medina, J. N. Smith, and A. Nenes, 2006: Mapping the operation of the DMT Continuous Flow CCN counter. Aerosol Sci Tech, 40, 242-254.

Roberts, G. C. and A. Nenes, 2005: A continuous-flow streamwise thermal-gradient CCN chamber for atmospheric measurements. Aerosol Sci Tech, 39, 206-221.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 8193, 2007.

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