Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2021-189

Anonymous Referee #1

Referee comment on "Calibration and evaluation of a broad supersaturation scanning (BS2) cloud condensation nuclei counter for rapid measurement of particle hygroscopicity and cloud condensation nuclei (CCN) activity" by Najin Kim et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-189-RC2, 2021

Kim et al. present the calibration of the broad supersaturation scanning CCN instrument. The instrument is a modified version of the DMT CCN, where the aerosol is entering the growth tube in a spatially distributed manner. As a result, particles experience a range of supersaturation. When fed with monodisperse particles, the activated fraction can be related directly to the hygroscopicity parameter of the aerosol at that size. The manuscript presents experimental calibration data for this instrument. Comparison with regular size-resolved CCN measurements shows reasonable agreement in the derived kappa for the two methods.

Overall the paper is well written. The method is clever and promises a faster time-response measurement with relatively small modifications to an existing widely available commercial instrument. The manuscript is relevant to the readers of AMT and I recommend publication if the following comments can be addressed.

Major comments.

Influence of multiply charged particles: The authors select the most optimistic scenario to conclude that the effect of multiply charged particles is small. Conditions of lower supersaturation and larger mode diameter will have a much more significant influence of multiply charged particles. Figure 4 should include s = 0.1% and Dg = 150 nm to bound the magnitude of the effect, which may be especially relevant in some ambient cases scenarios.

Time resolution: The promise of the technique is that kappa can be measured at much higher time resolution. However, the manuscript does not really show this very well. Figure 11 shows temporally averaged data. Perhaps this is necessary because the 1 min data are too noisy? If that is the case, it would undercut the argument of improved time resolution.

Related, there is a concern on what went into the average. Technically, the comparison should be for the size closest to the activation diameter of the size resolved CCN, which changes with time. The authors should be more precise when matching the kappa values in the comparison (i.e. only include +/- 1 size bin in their kappa intercomparison).

In general, the authors should discuss time resolution in a more nuanced manner. When pressed, scanning flow CCN and scanning mobility CCN can find an activation spectrum in 30s to 1 min time, which would provide a kappa value every minute. The D50/supersaturation could be adjusted by changing the flow rate after each scan. This may be inferior to finding the kappa value at a fixed size which the BS2 technique does. However, at face value the time resolution of what can be achieved with traditional methods would seem much more similar to what is achieved in this work, although that setup might be easily improved by changing the configuration (see below).

Related, it would be good to add discussion on the minimum time needed to get a kappa measurement. Why was 1 min selected? What determines the quality of the measurement? Is it the number of counts? If so can this value be specified? In principle, it would seem possible to run the system with a continuously scanning DMA (e.g. a 3 min SMPS scan) and then report the kappa data in a few discrete size bins. The feasibility of

such an approach would depend on the time required to obtain a good kappa characterization. The authors should provide detailed comments on what may or may not be possible with this technique.

The authors should discuss the new inlet in more detail. Were CFD simulations used to make sure that the flow is laminar? What are the limits of the angle to achieve laminar low? For maximum impact, the authors should consider publish their CAD drawings under a non commercial use license so that others can more easily implement this technique. (Publication of the CAD drawing is not a requirement for publication in AMT, though in the reviewers opinion it should be).

"Data can be accessed by contacting the corresponding author. ": This is incompatible with the data policy of AMT.

Other comments

Figure 3: The distribution doesn't peak at 50 nm as stated in the text.