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Atmospheric Measurement Techniques Discussions

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Interactive Comment

Interactive comment on "Scanning supersaturation CPC applied as a nano-CCN counter for size-resolved analysis of the hygroscopicity and chemical composition of nanoparticles" *by* Z. B. Wang et al.

Anonymous Referee #2

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Summary:

In this manuscript, the authors present the theoretical framework, laboratory characterization, and data reduction methods for a size resolved cloud condensation nuclei (CCN) spectrometer extended down to particle sizes as small as 2.5 nm. This was accomplished by using a Nano-DMA to provide mobility classification down to 2.5 nm and a water CPC to generate the super-saturations needed to activate the sampled nanoparticles. The composition-dependent response of the instrument was characterized and provides a means of inferring nanoparticle composition. The manuscript is recommended for publication, after the moderate/minor revisions listed below have been adequately addressed.

Requested revisions:

1. Page 11138, line 25: To be absolutely transparent, the instruments listed in Figure 1 are representative, rather than exhaustive of the aerosol instruments that provide composition information. Please clarify this. There are a number of other studies/instruments that provide size-resolved composition information (indirect). For instance, the Nano-TDMA provides indirect composition information (analogous to this nano-CCNC) down to 4 nm (Sakurai et al. 2005), and the nano CPC battery provides size-resolved indirect composition information from 1 to 3 nm (Kangasluoma et al. 2014).

2. Page 11139, line 16: Please amend “particle sizes” to “particle activation sizes).

3. Page 11140, line 7: When first describing the water CPC, please include a reference to (Hering et al. 2005).

4. Page 11140, line 11: It is rather vague to state that the curve of the CPC is the same as the curve of the CCNC. Please be more specific – same in what ways? In composition dependent response? In sharpness of the activation curve? Also, to be clear, are the efficiency data plotted in Figure 3 corrected for transport losses? If they have not been corrected for transport losses, then the efficiency data are more accurately referred to as detection efficiencies rather than activation efficiencies, since the impact of size-dependent particle diffusional losses have not been removed. Furthermore, aerosol transport losses will have the effect of broadening the resulting detection efficiency curve – this will be referenced later in this review.

5. Page 11140, line 14: It is not accurate to state that the CPC is mainly used for accurate particle counting (where the detection efficiency is ~ 1). For the scenario that

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the CPC is the particle detector in an SMPS (which is nearly almost always the case for an SMPS), it is absolutely critical to know the detection efficiency curve in the cut-off region (< 1). Please revise.

6. Page 11141, line 14: The statement that S can be scanned by scanning the aerosol flow rate of the CPC is not entirely accurate. In Gallar et al, it is not the aerosol flow rate that is scanned, but the the mixing ratio of dilution air and saturated air (as you proceed to describe later in the text). The aerosol (sample) flow rate was fixed in that study. In Wimmer et al, the CPC that could scan S was a turbulent mixing type CPC, fundamentally different than the laminar flow type CPC used in this study. In the turbulent mixing type CPC, it is the saturator flow that is scanned (not the aerosol flow) to scan S. Please revise.

7. Page 11142, line 12: It is not accurate to state that particle diffusion causes non-uniformity of exposed S. First, the spatial distribution of S is non-uniform due to the effects of simultaneous heat and mass transfer in a laminar flow system. While radial diffusion will lead to some degree of particle exposure to different values of S, the fact that there is a non-negligible cross section of the sample capillary will lead to the introduction of nanoparticles into the growth tube across the width of the capillary leading also to exposure to different values of S. Please revise.

8. Page 11142, line 24: As mentioned earlier, there is dispersion of the aerosol sample already due to the finite width of the sample capillary that introduces the aerosol into the laminar growth tube.

9. Page 11142, line 28: Were the efficiency presented in Figure 3 corrected for aerosol transport losses in each system? The impact of size-dependent nanoparticle diffusional losses will also act to make a step function more broad, along with the impacts of diffusion and the finite dimensions of the sample capillary in the water CPC. Please clarify this in Figure 3 and in the text.

10. Page 11145, line 17: What was the reasoning for using the WOx data to determine

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H(S)? With the right assumptions, are the H(S) calculated from ammonium sulfate, sucrose, and sodium chloride data consistent with each other? Please provide an explanation.

11. Page 11149, line 19: The instrument characterization presented in Kangasluoma et al. does include the size-resolved response of a nano CPC battery to aerosol of various composition to different working fluids. Please revise to reflect this.

12. Page 11163, Figure 5: In caption d, please revise “dimensions of activated particles” to “radial distribution of activated particles”. “Dimensions of activated particles” is awkward phrasing.

13. Page 11167, Figure 9: What is meant by “in the range of 57 to 75%, during which is indicative of ambient nanparticles”? Were ambient nanoparticles actually sampled with this system?

Sakurai, H., Fink, M. A., McMurry, P. H., Mauldin, L., Moore, K. F., Smith, J. N., Eisele, F. L. (2005). Hygroscopicity and volatility of 4–10 nm particles during summertime atmospheric nucleation events in urban Atlanta. Journal of Geophysical Research-Atmospheres 110:D22S04.

Kangasluoma, J., Kuang, C., Wimmer, D., Rissanen, M. P., Lehtipalo, K., Ehn, M., Worsnop, D. R., Wang, J., Kulmala, M., Petäjä, T. (2014). Sub-3 nm particle size and composition dependent response of a nano-CPC battery. Atmos. Meas. Tech. 7:689-700.

Hering, S. V., Stolzenburg, M. R., Quant, F. R., Oberreit, D. R., Keady, P. B. (2005). A laminar-flow, water-based condensation particle counter (WCPC). Aerosol Science and Technology 39:659-672.

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 11137, 2014.