The manuscript "Instrument Artifacts Lead to Uncertainties in Parameterizations of Cloud Condensation Nucleation" assessed the contributions of potential artifacts in CCN activation measurement to the uncertainties in hygroscopic parameter, kappa, using a theoretical way. The artifacts include the potential artifacts from DMA, CPC counting, and CCN counting. It presents results of several scenarios including various operating conditions of DMA (ratio of aerosol to sheath flow, ratio of sheath to excess flow), counting efficiency of CPC and CCN at varied aerosol concentrations. The authors found that the broadening of aerosol size distribution out of DMA by increasing the aerosol to sheath flow ratio led to an overestimate of kappa. The undercounting of particles by CPC at high aerosol concentrations led to an overestimate of kappa, while the undercounting of particles by CCN led to an underestimate of kappa.

Assessing the contribution of potential artifacts in CCN operation to the kappa is beneficial to the CCN community. The manuscript fits well the scope of AMT. However, I have some concerns before the manuscript is considered to be published in AMT.

General comments

1. This study used a pure theoretical approach to assess the artifacts in various CCN operating scenarios. However, many scenarios are not common in the real CCN activation measurement. For example, is very rare that the particle number concentrations at the output of DMA reach 1e4 # cm^{-3}, or even 5e6 # cm^{-3} as investigated in the section of artifacts derived from CPC and CCN. The authors suggested in the introduction section that the discrepancy in experimental results for ammonium nitrate and some organics in the literature are contributed by the artifacts in CCN measurement. An interesting question is to what extent the artifacts investigated here can explain the discrepancies in the kappa of ammonium nitrate, for example, in the literature.
2. The approach used to derive artifacts from DMA in this study is significantly different from the real CCN measurement. Firstly, in the real CCN measurement, uncertainties in SS_{crit} (accordingly kappa) are "produced" in the fitting of activated fraction of particles (either activated fraction vs. supersaturation(SS) for particles of a given size or activated fraction vs. particle size at a given SS). The artifacts derived from DMA was calculated by Eq. 12 based on "volume-weighted diameter-specific perceived κ_{app} values". I am not sure whether the artifacts in this study can reflect the real uncertainties in CCN measurement. Secondly, I am not sure whether the method used to calculate κ_{app} and (and to derive SS_{crit}) is appropriate. Why the authors used "volume-weighted" approach? In my opinion, when the particle size distribution broadens, the number of both the larger particle and smaller particles increase in a largely similar rate. Then the ratio of activated particles (larger particles) to total particles (measured by CPC) as well as SScrit and kappa should be relatively invariant. Could the authors assess the uncertainties in kappa using the way that kappa is derived in the real CCN measurement?
3. In the CCN activation measurement, the supersaturation of CCN counter is often calibrated using the theoretical data of $(NH_4)_2SO_4$ or NaCl in the literature (Rose, Gunthe et al. 2008). The kappa of the standards ($(NH_4)_2SO_4$ or NaCl) and the sample aerosol would have the bias of the same direction. This may largely compensate the artifact of CCN measurement and thus lessen the role of instrument artifacts in the discrepancy between different measurements. It may be helpful to discuss this aspect.

Specific comments

1. L62, why do the authors particularly mention sea spray aerosol among various aerosol types?

2. L457, it is worth noting that these values are for the artifacts of CPC or CCN alone. The artifacts from CPC and CCN counting at high aerosol concentration counteract. Therefore, the combined effect of the CPC and CCN is much lower as the authors mentioned in L445-447.
   Please also state that these values ("$-0.57 < \kappa_{app,rtifact} < 0.42$") are for NaCl.
3. L137, the literature of the kappa values is not provided.
4. L202, L is not defined.
5. L216, the detailed motivation of design these 7 cases are not available (although they are mentioned in the conclusion section).
6. L253, it is not clear how exactly the $\kappa_{app, theory}$ (and κ_i) is derived. ε_i and κ_i are not defined. Please elaborate. And why do the authors use volume-weighted kappa?
7. L266-268, the artifacts due to the ratio of excess flow to sheath flow are not really discussed here, even less than in the abstract.
8. L412-416, why would "a distribution with a narrower peak than the one generated for this analysis be at risk for larger κ_{app} artifacts for any total aerosol concentration…"?

Technical comments

1. I suggest numbering the section from the "Introduction".

References

Rose, D., S. S. Gunthe, et al. (2008). "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." Atmospheric Chemistry and Physics **8**(5): 1153-1179.