

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2021-1008

Anonymous Referee #1

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Referee comment on "Long- and short-term temporal variability in cloud condensation nuclei spectra over a wide supersaturation range in the Southern Great Plains site" by Russell J. Perkins et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1008-RC1>, 2021

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This manuscript introduced a best-estimate CCN spectrum product across a wide range of supersaturation range from 0.0001 to 30%, using multiple independent instruments at ARM SGP site. Cluster analysis is used to identify the key driving element (aerosol number size distribution) in CCN spectra. The seasonal and diurnal cycles of the clusters are analyzed as well as the time evolution of these clusters. This dataset is useful in aerosol and aerosol-cloud interaction study. It also has potential to benefit modeling study in high-SS or low-SS conditions. Overall, the manuscript is well written and I recommend it be published in ACP, with some comments listed below.

One aspect I think the authors can improve this manuscript is by adding more analysis and discussions on the uncertainty of the reconstructed CCN, especially in the high- and low-SS ends. Extending the CCN spectra into a wider range is a key point of this dataset. However, the authors also admit the data limits in the high and low ends of SS. This makes me wonder how good we can trust the data in the two ends. As the authors mentioned the uncertainty is included in the dataset, it would be helpful to add a plot of CCN uncertainty across all SS range and discuss how much we can trust the data. It would also be great if some discussions can be made on what can we learn from CCN in these extremely high (low) SS conditions.

Minor comment:

Title: since the wide SS range is a key point of this dataset, I would recommend adding something in the title to indicate that, such as "... Cloud Condensation Nuclei Spectra in a Wide Supersaturation Range ..."

Line 15: I am curious if the authors have any plan to extend this data to more recent

years. If yes, it will be good to discuss in the last of the manuscript.

Line 67: it would be good to list out (better within a table) the instrument names and size ranges used in building the aerosol size distribution and CCN spectrum.

Figure 1: is this example of one 45-min data sample? It would be good to present the date/time of the example.

Line 96-97: "... which can be used to check the accuracy of the reconstructed spectra." This sentence is misleading me that I thought this paragraph is to evaluate the data accuracy using independent datasets. I suggest deleting this sentence and changing the next one as "... that were used to constrain the reconstructed CCN spectra at the low-SS (and high-SS??) end"

Line 106: why six instruments here? In abstract and summary it says eight instruments. Also, it would be good to list all of them in a table.

Line 120-121: How is  $k$  calculated from GF distribution? Appendix A says  $k$  distribution is calculated from GF distribution then averaged into one single  $k$  value. I thought the GF distribution, either single-modal or bi-modal, can be captured in  $k$  calculation. Please correct me if my understanding is wrong.

Line 130: "..., and these particles this lowest  $SS_w$  region." Is this sentence incomplete?

Line 133: again, it would be great to add analysis on the data uncertainty and discuss what value can be added with this wide  $SS$  range.

Line 142: can you explain the advantages of using skewed log-normal distribution other than regular log-normal? Any reason why CCN number concentration (and other variables in Figure B1) fit skewed log-normal distribution better?

Line 151-155: This point is interesting. Can we find high correlation within each aerosol mode and low correlation between bins in different modes (such as nucleation, Aitken and accumulation modes)? will it give evidence to choose size ranges for each mode?

Figure 6: change the caption to "diurnal variability of cluster fractional likelihood"

Figure 6: it would be good to change the x axis label to 3-hr or 6-hr intervals. Same as other diurnal figures.

Figure 8: it would be interesting to add similar plots for aerosol number size distribution.

Line 291-292: I don't understand why "indicate short-lived events tied to diurnal

cycles". Shouldn't the nucleation mode particles be tied to new particle formation events?

Eq. 3 in Appendix A: as it mentioned GF at a given RH is abbreviated to GF above, and GF is used in Eq.2, here GF(RH) should be GF for consistency.

Data availability: reference (Atmospheric Radiation Measurement (ARM), 1995, 2001, 2007, 2010, 2011, 2015) are not seen in the reference list.

Data availability: The final merged aerosol number size distribution and CCN data link (<https://doi.org/10.5439/1832908>) doesn't work. Please check if the DOI is correct or if the data haven't yet published in the ARM Archive.

Line 497: not complete: "is available at XXX"

