

Atmos. Chem. Phys. Discuss., referee comment RC2  
<https://doi.org/10.5194/acp-2021-1008-RC2>, 2022  
© Author(s) 2022. This work is distributed under  
the Creative Commons Attribution 4.0 License.

## **Comment on acp-2021-1008**

Anonymous Referee #2

---

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-RC2>, 2022

---

## **Review of "Long- and Short-Term Temporal Variability in Cloud Condensation Nuclei Spectra in the Southern Great Plains" by Perkins et al. submitted to ACP [acp-2021-1008]**

This study investigates the temporal variability of the five-year CCN observations at the ARM SGP site. The authors first constructed the CCN spectra database covering a wide range of supersaturation (SSw) conditions by combining concurrent aerosol size distribution and hygroscopicity ( $\kappa$ ) obtained from multiple instruments. They then conducted three statistical analyses using this data set, namely (1) parametric fitting of the CCN PDF; (2) cluster analysis of the CCN spectra; (3) temporal autocorrelation of the CCN number concentration time series. From each analysis they concluded that (1) the skewed log-normal distribution fits the CCN PDF; (2) there are three distinct clusters of CCN spectra and they are associated with aerosol size distributions dominated by different modes of aerosol particles; each cluster has distinct seasonal and hourly fractional occurrence; (3) the time scales of CCN number is shorter (1-3 hours) in high SSw condition than in low SSw condition.

Overall, this is a clearly written manuscript. I agree that these multiple-year CCN spectra spanning the SSw condition from strong updraft in deep convection to fog are potentially useful for simulating cloud and precipitation formation as well as for the development of microphysics parameterizations. Applying cluster analysis to the CCN spectra is also a novel idea to explore the long-term dataset. The quality of the analysis and presentation meets the standard of the ACP. However, I found several questions/clarifications that need

to be addressed, as listed below. If these issues can be properly responded to or revised, I would suggest the manuscript be accepted for publication.

#### Specific Comments/Major Questions

- The scientific goal of the study and the relationship of the three statistical analyses (i.e., log-normal fitting of CCN PDF, cluster analysis of CCN spectra, and autocorrelation of CCN number concentration time series) need to be further clarified

When I first read the abstract, I was confused by how the statistical analyses are interrelated (e.g., the clustering was based on the fitted CCN PDF, or the autocorrelation was applied to the time series of cluster occurrence). It was until I read through the entire manuscript that I realized they are actually three separate results. Therefore I suggest to

- Revise the abstract to explicitly clarify these analyses as three different tasks and their specific objectives.
  - Add a few sentences to state the scientific goals of this study and the organization of this manuscript to the end of Sec.1
  - Augment the method section – At least move some of the basic descriptions of the three statistical analyses from the appendix to the method section.
  - Restructure section 3 – It is strange that there is no result section and the discussion section immediately follows the method section. Please separate results and discussion clearly. The median kappa test, for example, belongs to the discussion section instead of the direct results.
  - More systematic and quantitative discussion on the uncertainty of the dataset is needed, particularly focusing on the assumption when deriving the CCN # for extreme SSw conditions. Please also discuss how the uncertainty in CCN spectra may influence the statistical analysis results.
- 
- I also think the title needs to be revised to highlight either the value of the CCN data set or the statistical analysis results. “Short- and long-term temporal variability” is a vague description

- Please provide more details on the cluster analysis.

For example, what was the actual input ( $x$ ) to calculate the distance metrics? The original CCN spectra (i.e. CCN # as a function of SSw) or some normalization was applied? When saying the clustering was based on distribution shape (L458), do you mean the clustered results exhibit distinct functional distributions of CCN # along with SSw? Or the CCN spectral shape was used as the input?

As the variability of the CCN spectra is orders of magnitude higher at the higher end of SSw (and similarly the variability in the aerosol size distribution is much higher at the smaller sizes), the clustered results would mainly be more sensitive to the high SSw conditions (nucleation mode aerosols). Have you compared the clustering based on the normalized spectra, the normalized aerosol size distribution, or even the fitted CCN PDF as a function of SSw?

The authors mentioned that Kappa is not the main controlling factor of CCN spectra type. Maybe the aerosol composition in SGP is similar? Please add some discussion on the aerosol composition variation in this dataset.

- It seemed all the "size distribution" in the manuscript refer to "aerosol size distribution"? Or do some of them actually refer to the "CCN size distribution"? Please make them more explicit.

#### Technical corrections/Minor Comments

- L23 Abstract: More specific/qualitative conclusion on the time scales
- L67: Adding a table to list the instruments used in constructing the data set
- L95, Fig.1 Caption: blue à black
- L218 reconciling seasonal particle data and cluster: please elaborate the sentence

## Data availability and supplement link

- L491 "(ARM), 1995, 2001, 2007, 2010, 2011, 2015)": it's confusing that the years mentioned here are inconsistent with the years mentioned in the main text (2009-2013)
- L494 "merged aerosol number size distribution and CCN data (<https://doi.org/10.5439/1832908>)": This DOI cannot be found in the DOI System
- L497, "skewed log-normal fit coefficients for all CCN data, named CCN\_fit\_coeffs.txt, is available at XXX". à missing information