

Interactive comment on “What do we learn from long-term cloud condensation nuclei number concentration, particle number size distribution, and chemical composition measurements at regionally representative observatories?” by Julia Schmale et al.

Anonymous Referee #1

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Schmale et al. present in their manuscript an analysis of cloud condensation nuclei (CCN), particle size distribution and particle chemical composition measurements recorded at twelve sites from three continents. A closure study based on the measured particle size and chemical composition and applying the κ -Koehler parametrization is performed to test several simplified assumptions potentially be used to predict CCN concentrations. The applied methods and analysis steps appear as sound and valid. The results are described and discussed in sufficient detail. Overall, this work is of clear

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interest to the scientific community. Only a few clarifications, as well as minor changes to text and figures are needed before it can be published in ACP ([minor revisions](#); see comments below).

Detailed comments

1. The manuscript is in some parts quite lengthy and makes the reading for some parts slightly difficult. The abstract almost reads like an introduction and could be substantially shortened to the main findings. Most of the data treatment (incl. technical tables) and site descriptions are already published in the data descriptor paper and could thus be shortened as well.
2. Page 5, line 18: The particle's hygroscopicity is another important parameter needed for the simulation of CCN concentration, which should be mentioned here (incl. references).
3. Page 8, line 16: What errors can be expected when integrating the monodisperse CCN measurements over the covered size range in order to be comparable to the polydisperse mode? I guess this will depend on the specific selected diameters and the number of selected diameters (resolution).
4. First paragraph on page 12: Sodium chloride is not part of the E-AIM II model. How was this treated?
5. Figure 2: It should be clarified (e.g. in the caption) that the values from Petters and Kreidenweis (2007) in the subsaturated domain were determined at $a_w \sim 0.9$. It should also be mentioned that the values in Petters and Kreidenweis (2007) for NaCl are too low and should rather be $\kappa \sim 1.5$ (at $a_w \sim 90\%$) as recently shown by Zieger et al. (2017).

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6. Sect. 2.3.2: The influence of sea salt, which is not properly detected by the AMS or ACSM, on the overall κ should be further discussed. Sea salt is not just limited to coarse mode particles (see e.g., Salter et al., 2015) and is clearly observed in measurements even at rural background sites like Melpitz or Cabauw (see e.g., Zieger et al., 2011, 2014) also for longer time periods.
7. Page 15, line 2-3: Where the air masses from the polluted sector at MHD excluded from the analysis? I wonder because MHD is classified here as 'coastal background' station.
8. Page 17, second paragraph and Fig. 5: The calculation of the persistence needs more detail on the calculation method and its uncertainty. In the beginning of the paragraph, it states that 'The persistence is essentially a metric for how long the CCN number concentration remains similar.'. However, this is in contradiction to the discussion of the mountain stations later on ('... the high persistence is an indication of a regular pattern rather than a constant CCN number concentration'). Maybe rephrase this part. Why are the other seasons not included in Fig. 5?
9. Page 20, line 16: Please specify what 'A certain relationship' means.
10. Page 22, line 25: I can't find the here referred white symbols in Fig. 10a.
11. Figure 4: Please clarify on the following:
 - BRW shows no interquartile ranges in the summer with respect to CCN concentration.
 - MHD misses the CCN concentration for the summer, but shows the derived critical diameter (panel c) in summer.
 - VAV misses the values for the critical diameter in fall but shows values for CCN concentration during that period.

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12. Figure 7: The measured or assumed BC used for calculating κ is missing in panel (a).
13. Figure S3: Please clarify if values in panel (d) are shown as mean values for the entire supersaturation range.
14. Table 1 is not really needed and partially repetitive to the information shown in the data descriptor paper. It could therefore be moved to the supplement. It also shows the collection efficiency for the various ACSM and AMS measurements, but the importance of these values are not discussed in the manuscript. Please add a discussion on it or remove this information from the table.
15. Table 2: The last column is not really needed here and could be removed.

Technical comments

1. Page 7, line 24: Here and throughout the manuscript, 'Fig.' should be 'Figure' at the beginning of the sentence (see https://www.atmospheric-chemistry-and-physics.net/for_authors/manuscript_preparation.html).
2. Page 7, line 31: This sentence is a repetition from line 13 on the same page.
3. Page 8, line 3: CCN was already defined in the abstract and the introduction.
4. Page 8, line 5: Repetition (see page 7, line 29).
5. Equation 1: ' r_k ' should not be in subscript.
6. Page 12, line 17: Space missing.

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7. Page 13, line 6: Replace 'at' with 'as'.
8. Page 13, line 25: I assume you mean Eq. 6 in Petters and Kreidenweis (2007)?
9. Page 19, line 17 and throughout the manuscript: Since the subscripts relate to chemical components and not to variables, add '\rm' in the subscript if using Latex or remove the italics.
10. Figure 1: The colour code in panel (a) is difficult to distinguish. I would suggest to use different symbols or write the station names next to their symbol on the map.
11. Figure 6 and throughout the manuscript: Please be consistent in placing the units in parenthesis.
12. Figure 8: Units are missing for the x-axis.
13. Figure 9: The colours are difficult to distinguish, please use different markers. Why are the first values for FIK shown without errorbars?
14. Figure 10: Change the x-axis label to 'ratio predicted/measured (geometric mean)', since a ratio and not a geometric mean is shown (otherwise a unit would be missing).
15. In the tables, please harmonize the case sensitivity and the usage of hyphen.
16. Table 3: Please replace 'and' by 'to' and/or add ' $CCN_{0.5}^{pred.}/CCN_{0.5}^{meas.}$ ' to the table caption.

References

Petters M. and Kreidenweis S., A single parameter representation of hygroscopic growth and cloud condensation nucleus activity, *Atmos. Chem. Phys.*, 7(8), 1961–1971, doi: 10.5194/acp-7-1961-2007, 2007.

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Interactive comment on *Atmos. Chem. Phys. Discuss.*, <https://doi.org/10.5194/acp-2017-798>, 2017.

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