

Review of egusphere-2024-956

This manuscript presents the CCN data obtained from shipborne measurement over the South China Sea. Because CCN measurement is still lacking, and especially measurement over the sea has been even rarely done, presenting CCN data measured over the sea is very valuable. However, this manuscript lacks the integrity and quality of a paper that would be worthy of being published in ACP. First, measurement setup and data analysis methods are not clearly explained. Figures and Tables are not clearly explained in captions and lack some important information. English should be greatly improved. For these reasons, I recommend resubmission of the manuscript after all my comments are addressed properly. Below are my specific comments.

Major Comments

Section 2.1.2:

Explain clearly how size-resolved CCN and PNSD were measured simultaneously. Do the authors have an SMPS for PNSD measurement and a separate DMA that can be used to setup a DMA-CCNC system for size resolved CCN? If that is not the case, with one SMPS, how can they measure both? The authors have CCNC-200 that has two CCN measurement columns. So, it could have been possible to use one column for size resolved CCN measurement and another for regular CCN concentration measurement at several SSs. But apparently CCN concentration at a given SS was obtained from the integration of size-resolved CCN data, instead of making direct CCN measurement. I wonder why the two column capability of CCNC-200 was not fully utilized. No clear explanation is given. Relevant to this section is the fitting results in Figure S3, which seem to show the averaged size-resolved activation ratio (AR) for the entire summer and for the entire winter periods, respectively. Since the aerosol characteristics are likely different for different air masses, the size-resolved AR should be estimated for each cluster and then calculate D_{50} . Apparently the authors have done that (Fig. 7). Then I wonder how the results of Figure S3 are produced. The authors should clearly explain.

Section 2.2.3:

Why did the authors predict CCN concentration when direct measurement was possible with one of the two columns in CCNC-200? Anyway, later in the manuscript, this “predicted” N_{CCN} was apparently used as $N_{CCN,obs}$, when doing the CCN closure. Is this really the case? Explain clearly.

Section 2.2.4:

Regarding the cluster analysis, which method is used to classify the clusters? Is it a hierarchical clustering method? If so, is it bottom-up approach or top-down approach? If not, is k-means clustering method or fuzzy c-mean clustering method used? The authors should describe the

method clearly.

It is implied that the authors know exactly on what day the summer monsoon started. Can this be so clearly known? If so, explain clearly how so by showing the supporting data (e.g., wind pattern change, ...).

Unlike ground (fixed location) measurement, cluster analysis for ship measurement requires some caution since the research vessel is moving (i.e., cruising). To ensure the representativeness and suitability of the midpoint used as the starting location, the back trajectories for the ship's coordinate during the cruises and the back trajectories for the midpoint of the ship track at the same time should be close enough. The authors should confirm if this is the case by showing supporting data.

Section 3.1:

The absolute difference of N_{CCN} between the two seasons was larger at higher SS but that should be natural since N_{CCN} becomes higher at higher SS. The comparison should be relative: the ratio of $N_{CCN_{winter}}/N_{CCN_{summer}}$ at a given SS should be shown for such comparison.

The κ values shown in Table 1 and Fig.3a do not match for 0.4% SS (0.74 vs. ~0.60). In the text, it is 0.72. A good example of poor sincerity of this manuscript! At 0.2% SS, summer and winter κ were 0.49 and 0.31, respectively. Can they be considered "similar" as the authors stated? I do not think so.

It should also be noted that the estimated κ values are for the particles of critical diameter (D_{50}), the smallest particles that can be activated at a given SS. So, these κ values do not represent the κ values of all the particles that can be activated at a given SS. This should be stated clearly before any arguments are made on κ values.

Section 3.2:

To ensure that cluster analysis is well-conducted, I would suggest that the authors present all the back trajectories classified in each cluster in the supplement.

If a back trajectory does not stay long enough within the boundary layer, it is difficult to say that it reflects the characteristics of the air masses where it passed. Therefore, it is recommended that the altitude of the back trajectory is also presented, to more clearly demonstrate the influence of the specified regions like "Mainland China", "Luzon", and "Indochinese Peninsula" on SCS. This can be confirmed by averaging the altitudes of all backward trajectories in each cluster.

The authors state that low hygroscopicity of 'Mainland China' could be due to low sulfate concentration oxidized by DMS in winter than in summer. Here the comparison is between 'Mainland China' and 'Luzon,' the two terrestrial regions. So I do not understand why DMS production is discussed here, which are definitely the source of CCN over marine regions. Explain the relevance.

Minor Comments

Line 117: “different impacts on CCN activity differently across seasons” --> “different impacts on CCN activity across the seasons”; What does “high cloud fraction” mean? Fraction of ‘high cloud’ or high fraction of clouds? If the former is the case, why is this relevant?

Line 134: “different monsoons” --> “summer and winter monsoons”

Line 148: Add the information of the actual height of the sampling lines from the sea surface.

Lines 172-175: Since no result on OC/EC were discussed in the manuscript, it is inappropriate to mention OC/EC in Section 2.1.3. Likewise, the discussion of trace gases seems not to be presented in the manuscript and/or supplement. It might be worth checking.

Lines 181-182: Writing December 22nd as 12.22 can be confusing to readers. Unify the expression for date throughout the manuscript. Better to be December 22nd or 22 December but not 12.22.

Line 186: ‘praticle’ --> ‘particle’

Line 191: “AR is the size-resolved AR” --> “AR indicates the size-resolved AR value” In several occasions later in the manuscript, AR seems to indicate the bulk AR value. These should be clearly explained.

Line 210: “ κ from ...” --> “ κ for ...”, ‘Nacl’ --> ‘NaCl’ here and for other occasions.

Line 211: κ of organic was assumed to be 0.1. Where is it from?

Line 217: Eq. (4) can give predicted CCN concentration under the assumption that all particles of diameter greater than D_{50} activate for the given SS. Where is the justification?

Line 219: “number concentration under specific” --> “number density of specific”

Line 230-233: What does “have identical concentration at each size” mean? Is this intended for “fixed proportion for all sizes?” How does D_{50} calculated for each species? Explain clearly.

Line 236: In Eq. (6), $N_{CCN,obs}$ is not an observed value, strictly speaking. Be clear on this.

Line 246: ‘outbreak’ --> ‘onset’

Lines 280-281: Aerosol number concentration is higher in summer than in winter, but mass concentration is higher in winter. Based on Figure 3, however, Aitken mode particles are much more abundant in summer, while accumulation mode particles, which greatly affect mass concentration, are similar between summer and winter. Then, why are aerosol mass concentration significantly different between summer and winter? Need more explanation.

Line 296: Add (Cai et al., 2020) after “Guangzhou”, just like in the previous sentence.

Line 363: “NMB always lower” --> “NMB was always lower”

Line 386: “study size-resolved” --> “study of size-resolved”

Line 414-415: “higher particle fraction in the accumulation mode compared to” --> “higher fraction of the accumulation mode particles compared to”

Line 434: In “northern SCS,” what does ‘northern’ exactly mean? The winter cruise route shown in Fig. 1 does not seem to indicate cruising over northern part of SCS. In the same context, what does “remote SCS” mean?

Table 1: Show D_{50} values at least for this study. Is AR a bulk AR value? Explain in the caption. Why ‘Northern’ for winter cruises? There are several CCN measurement studies over the Yellow Sea, which would represent influence of northern part of continental China and therefore can provide good contrasting results.

Table 2: Add AR values in a separate column and widen the column to show data in one line.

Figure 1: Add important place names and mark the mid-points of back trajectories in (a).

Provide full explanation in the caption.

Figure 4: Show important place names.

Figure 7: Why are there no κ plots for Indochinese Peninsula and Marine for 0.7% SS? Explain in the main text.