

Interactive comment on “Enrichment of submicron sea salt-containing particles in small cloud droplets based on single particle mass spectrometry” by Qinhao Lin et al.

Anonymous Referee #2

Received and published: 13 May 2019

This manuscript samples clouds from a mountain site in China using a ground counterflow virtual impactor (GCVI) and a single particle mass spectrometer. The authors used different cutsizes on the GCVI to look at different slices of the cloud droplet size distribution. They then identified only sea salt-containing cloud residues and compared the chemical mixing state of the sea salt particles across the different cloud droplet size cuts.

I think this paper did a nice job of referencing relevant literature; however, I think more attention needs to be paid to the role of cloud processing on the chemical makeup of the cloud residues. I think this paper needs major revision before publication.

C1

General Comments: What about cloud processing? You don't really discuss cloud processing and how this could affect your results or interpretation of the results. I think this is a mistake and you should think about how cloud formation and cloud processing will influence the size of the cloud droplets as well as the chemical makeup of the cloud residues.

How quickly was the cutsize changed on the GCVI? What were the sampling time periods for each cutsize?

What is the lowest size cut that the GCVI can reliably produce? Was the data for the lowest size cut given in the paper so different from the rest because there was a more breakthrough at the lower size cut? Did you see more supermicron particles at the lower size cut?

Specific Comments:

Lines 18-19: “The effect of size-resolved sea salt-containing particles on cloud condensation nuclei (CCN) is incompletely understood.” This sentence doesn't make sense. I would remove “size-resolved” or specify more clearly that sea salt particles of different sizes have different chemical compositions and thus different CCN activities.

Lines 29-32: This sentence is confusing as written. I would rewrite to say that nitrate was internally mixed with over 90% of particles and continue this phrasing with the rest of the compounds listed.

Lines 32-35: Same comment as above. Rephrase to state these compounds are internally mixed with X% of particles.

Lines 40-43: “The observed findings of this study highlight the enrichment of submicron sea salt-containing particles in small cloud droplets, which would induce decreased precipitation and, in turn, affect their residence time in the atmosphere.” Why would the presence of sea salt in clouds decrease precipitation? Are the concentrations so great that the cloud droplets do not grow large enough to precipitate?

C2

Line 69: Aged should be aging

Lines 94-96: I don't understand this sentence. Why would the cloud droplet size dictate or correlate to the sea salt size?

Line 145: SPAMS is misspelled.

Line 220-221: "In contrast to these findings, our results reflect that sea salt-containing nuclei are insensitive to the increase in the cloud droplet size." But you just stated that the number fraction of sea salt particles changed with different GCVI cut sizes. Please explain what you mean.

Lines 246-249: "together with the enrichment of sea salt-containing cloud residues for the minimum cut size of $7.5 \mu\text{m}$ that was observed here, this might indicate that the distribution of sea salt-containing cloud residues that were dependent on cloud droplet size is likely influenced by changes in the chemical mixtures of sea salt-containing nuclei." What about cloud processing? Couldn't it be that the smallest cloud droplets are the youngest and thus had less time to undergo cloud processing? That could be why there is a smaller amount of secondary species observed in the smaller cloud droplets. Also, how quickly were you switching between the different cut sizes? Where the different cutsizes measured on the same day or different days? This could affect the results.

Lines 295-305: No. This implies that the nitrogen could be integrated into the particles during atmospheric transport and the sulfate and ammonium are likely introduced by cloud processing, thus why they are present in the larger cloud droplets.

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2019-143>, 2019.