

Review for “Response of a liquid water cloud to in situ hygroscopic seeding” by Simmons et al. for ACP

Summary

This study presents chamber experiments of hygroscopic seeding materials injected into a steady-state liquid cloud. In total, three seeding agents were used: NaCl, CSNT (NaCl-TiO₂), and Arizona test dust. The authors observe upon injection of either NaCl or CSNT the “collapse” of the cloud, i.e., vanishing of small cloud droplet, while large cloud droplets appear before sedimenting. In the case of dust seeding, an opposite effect is observed: the cloud does not collapse, but thickens with increasing cloud droplet number concentration. The results are further extended by a discussion on applicability of hygroscopic seeding, with a focus of a minimum size of the to be injected aerosol particles.

I believe the study is well conceived and carried out and provides finally an experimental investigation for hygroscopic seeding. As the authors state, the focus has been mostly on silver iodide in the last decades. I have comments of “minor” and “major” nature. However, the major comments are more curiosity questions than addressing any major issue. Overall I can recommend this study for publication with minor revisions.

Major comments

- **Cloud collapse:** In Line 89, the definition of the cloud collapse is not properly done in my opinion. Only after presenting all results, a discussion and hypothesis on the process chain is done. I believe the understanding of this process chain is crucial and comes here too short. It is fine to have the discussion of the cloud collapse after the first result presentation, but then I would avoid having this very short definition here early on in the text. It rather raises questions than it helps the reader’s understanding.
- **Changes in LWC:** I am missing some uncertainty parameters on the measurements. Looking at Figure 3a, there is a single data point (is it one measurement or an average?) at 10 g/m³ right after the injection seeding material. Is this trustworthy? How confident are the authors on the single data points? Would a running mean help here?
- **Different responses across the seeding agents:** I would be curious to hear the authors thoughts on the underlying mechanisms in the seeding responses of all three agents. What is the mechanism for the dust sample? If it does not grow hygroscopically, what is happening? Why is the change in T_s higher for NaCl than for CSNT (Figure 4)? Why is the cloud collapse longer-lived in CSNT than for NaCl?

Minor comments

- “microns”: in several instances throughout the manuscript microns is used, I would prefer the proper unit in μm .
- Line 9: I would specify the size of the background cloud population to highlight the change in size more clearly
- Line 17: I would just call them ice nucleating particles, and avoid having after the first sentence already a bracketed information.
- Line 27: Here caking is used without explanation, while in Line 31 caking is added after dispersal. A short explanation about that would help to make the manuscript more accessible to wider audience.
- Line 39: “KCl” was not introduced and is not used later, so I would spell it out.
- Line 88: I do not expect any appendix on the tests of dry air entrainment, but would like to have some more quantifying statement than “minimal impact”.
- Line 97: “drop” to “droplet” to be consistent with the wording in the manuscript
- Figure 2: why is here the injection time at 900 s and not 600 s (same goes for Figure 3)? What do the data points represent? Are these averages or the 1 Hz recorded data points?
- Line 138: second “and” after CSNT is too much
- Figure 4: I recommend to replot this figure by avoiding having same line widths for the injection time and the time series. It is hard to distinguish. Changing the line width for the injection time as well as the color for CSNT will solve this issue.
- Appendix B: the additional figures should at least be referenced in the main text.