

Review of 'Response of a liquid water cloud to in situ hygroscopic seeding'

Authors: Simmons et al.

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The authors present results from an experiment in which hygroscopic aerosol are introduced into a steady-state cloud in the Michigan Tech Pi Chamber. Two materials are tested: a milled Sodium Chloride (NaCl) and a core-shell material composed of Sodium Chloride and Titanium Dioxide (NaCl-TiO₂). The latter material is designed to resist 'clumping' but retain the hygroscopic characteristics of a simple milled salt. The authors also tested a dust aerosol as a type of 'control' for this experiment.

In summary, the measurements from these experiments show that following the introduction of each of the two test materials, the 'base cloud' – the droplets that essentially made up the steady state cloud prior to introduction of the test material – collapsed. The original small cloud droplets evaporated. Nearly simultaneous to this collapse, large droplets (10's of microns larger in diameter compared to the mode of the base cloud) formed before eventually settling out and the cloud returning nearly to its pre-injection steady state condition.

The authors did a good job of describing the experimental setup and presenting the results of the experiment. I think it is an informative experiment with interesting results and as such is worthy of publication. I'm not sure I'm in 100% agreement with all of the author's interpretation and/or conclusions. I'm not saying they are wrong, I just don't know. For that reason, I think it would be useful for the authors to address some questions below that may help establish the validity of interpretation of the results.

For this reason, I am recommending major revisions.

Major comments:

1. It seems odd to me that the LWC should increase so much following the injection of NaCl and the injection of NaCl-TiO₂. The baseline cloud in both cases had ~0.05 g/m³ LWC, but had spikes up to and exceeding 4 g/m³ after the test aerosol were injected. Is that much vapor available for uptake even if the RH in the chamber drops to the deliquescence value of ~80%? Also, why is there so much variability in the LWC values---I would not expect that. Is it possible that this is a result of poor sampling statistics of the larger droplets that are contain most of the mass of liquid?
2. The results from the Arizona dust are also interesting, and seems counter-intuitive. The concentration increases *significantly* (albeit, mostly at small sizes, Figs 1 and B3)...this must result in a significant increase in LWC (not shown), but why? Why should the LWC increase after the injection of the dust?
3. For NaCl, following 600 s after injection the cloud returns to something that looks pretty similar to the baseline cloud (Fig B3), but this is less true for the NaCl-TiO₂ and even less for the dust. Why?

4. What are uncertainties associated with the measurements provided by the Welas and the CDMS-2? Are they identifying some of the dust and/or dry particles as liquid drops? If so, are they missing them? While the results from the 2 instruments look similar (Fig 1 and B1), there are certainly differences. Are those differences significant when calculating bulk properties of the cloud? What does the CDMS-2 measure during the dust test?

Minor comments:

1. Many of the figures are plotted as a function of time and demonstrate changes from before to after the injection of the test aerosol. However, the authors change the reference times used in many of the figures (Fig 1 for instance has the injection at shortly after 600 s, Figs 2 & 3 have them shortly after 900 s, and fig B1 have time in minutes). All of these figures should use the same time scale...and I further suggest that time $t=0$ s can be set as the injection time, such that pre-injection, time is negative and post injection, time is positive.