

Review for “Explicit Numerical Simulations of Hailstorm Seeding with a Three–Moment Microphysics Cloud–Resolving Model: A Comparison of Two Operational Methodologies for Hail Suppression” by Savić et al., EGUSphere

Summary

The study investigates the feasibility and impact of hail suppression using a numerical model with a three-moment cloud microphysics scheme and a two-moment aerosol microphysics scheme at a high horizontal resolution of 500 m. The authors evaluate two operation seeding methods, RHSS and AB23, with respect to their skill to reduce hail damage. A proper introduction to the topic is given and the authors try to cover the huge range of processes interacting in an convective, hail-producing cloud by showing detailed analyses of process rates. Before I can recommend the study for publication, I believe my major comments below need to be addressed first.

Major comments

- **Statistical significance:** The authors rightly point out the chaotic and non-linear nature of convective storms. They also reference studies, such as Papaevangelou et al., (2025, 2026), who employed ensemble strategies to exactly account for this. Why was not a similar strategy employed here? Having at least a small ensemble (e.g., 10 members) would already help robustly quantifying the effect of hail suppression techniques. I strongly recommend to perform additional simulations, where the radio-sounding profile is (slightly) adapted to initialize the storm. I believe only then concluding remarks can be drawn in terms of hail suppression efficiency. Currently, I am missing any statistical measures in the analysis. To me, it is not clear, why the total number/mass is usually shown. In Figure 6, it also looks like the differences to CTRL in the hydrometeors are very small? Except for snow and raindrops. I would like to see difference plots at least for the process rates from Figure 7 onward, but also for the data shown before. It is very hard to distinguish anything. I also think the mass and number plots should be combined into two-column subplots, with maybe 3 rows, where the process rates are distinguished by liquid, ice, and mixed processes. Currently, it takes quite a long time to do a comparison (visually). Combining figures and conducting a statistical analysis (e.g., in the form of box plots etc.) will help the reader to better grasp what are the take-aways, and will drastically reduce the large number of figures, that appear to be repetitive but are not. Along the same lines is the issue of numerical noise. Are the authors sure, they are not looking at numerical noise for process rates, such as in Fig. 12 (not exclusively here)? That is why, I believe an ensemble simulation approach is required to overcome these issues. Consistent usage of colors for the same processes across all figures would also help to make comparing them more straightforward. I know that Figure 19 shows differences, but exactly these look to me like numerical noise, because of the switching of neg/pos high exponents. Unfortunately, it is next to impossible to read anything from this figure. The authors also mention that these are 1 min averages, so what is the data output frequency of the model? Here the method sections needs to be expanded, such that is clear what quantities over what spatial / temporal range are looked at.
- **RHSS vs AB23:** I think it would be highly beneficial for the discussion of the results to have a table outlining the pros and cons of each method. While I like the sketch in Figure 1 a lot, I am missing in the comparison of the two methods, why we have this differences, and by that, why should we care about that? Why was RHSS chosen to show the detailed microphysics discussion, and then AB23 is suddenly re-discussed regarding hail reduction? Are these seeding methods actually feasible? RHSS has a rocket-based seeding system, correct? So are they shooting rockets every 5 min into the cloud? What is an approximation and testing setup in the model (which is absolutely fine to do) compared to the operational setting?
- **Seeding:** While there are studies already introducing and validating the seeding, I believe a section on how the seeding particles interact with the hydrometeors is required and how they are seeded. I was confused by all the options from the operational setting. DeMott (1995) proposed several freezing pathways for silver iodide, and I believe a short recap would greatly help to better understand the signals in the changes in process rates. Also, sometimes I am not sure if the aerosol particles interact with the hydrometeors, i.e., via immersion freezing, or if they are “only” scavenged and washed out? Am I misunderstanding here some process rates? A clarification would be greatly appreciated. This would also help to understand the zigzag and wavy pattern in, e.g., Fig. 5 in the cloud droplets, total, and air. This is also connected to have a proper description in the methods section on how the shown metrics are computed. More of a side note: please ensure that the labeling of the seeding particles is consistent in the manuscript (AP, seeding particles, aerosols, reagent, ...) to avoid any confusion.

Minor comments

- Line 109: cloud electrification: I would appreciate a bit more details and why this is important
- Line 115: Is the ratio of vertical and horizontal grid spacing good enough? What are the experiences of the authors?
- Line 116: I do not understand the two model time steps.
- Table 1: Maybe think of having a column with the processes and then the check marks where they are active for each hydrometeor class.
- Line 184: the bullet point list can be moved to Table 2 as headers
- Line 211: In what way is the movement of the supercell anomalous? You are initializing it with the radio-sounding, right?
- Line 213: Location of the maximum updraft in what space? x , y , z ?
- Maybe an overview of the seeding within the model grid could be useful to easier understand what is done.
- Figure 2 has a lot of different time stamps. What is it really? And where was this profile taken? Can not needed and not explained information from this figure be omitted?
- Figure 3: I believe the model spun up within 30 min? Is this correct?
- Line 261: I do not understand the difference in seeding material in the two methods?
- Line 271: Why is the strongest signal in cloud droplets?
- Line 279: A visual representation of the supercooled liquid zone and how the supply in AB23 is lower would be great.
- Line 327: What is the mechanism behind the conversion of small raindrops to cloud droplets upon seeding? What is happening and why?
- Figure 9b: It looks like the process of converting rain to hail is reduced in RHSS, why? How does this relate to that hail in Fig. 6 remains fairly constant? Is there some compensation?
- Line 368: What is sorption freezing?
- Line 506: How can seeding induce a shifting, stretching, and shrinking of the hail mass and number mixing ratios? What does this mean?
- Line 551: the beneficial competition should be mentioned in the introduction.
- Discussion section can be combined with the conclusion part.