Review for "Accelerated impact of airborne glaciogenic seeding of stratiform clouds by turbulence" by Meilian Chen, Xiaoqin Jing, Jiaojiao Li, Jing Yang, Xiaobo Dong, Bart Geerts, Yan Yin, Baojun Chen, Lulin Xue, Mengyu Huang, Ping Tang, and Shaofeng Hua

The manuscripts discusses a cloud seeding case study used for investigating the effect of turbulence on the dispersion of the seeding plume, the ice nucleation, ice crystal growth, and subsequent precipitation formation. It employs idealized WRF LESs to quantify the effect of turbulence. The authors provide a nice overview of the case study and their methods. Their findings are interesting for the scientific community focusing on mixed-phase clouds. In general, the manuscript is well written using clear language and the figures are well done. I do have comments regarding study setup and scientific conclusions. After addressing them, I recommend the manuscript for publication.

Major comments

- Throughout the manuscript, different time scales are discussed (e.g., glaciation time and turbulent mixing). In lines 34-37, the complex interplay of cloud seeding effects, dynamics, and microphysics is mentioned. It would be helpful if the authors can spend more time on that, as this is at the heart of their study. How are dynamics and turbulence separated? The idealized simulations employ a horizontal resolution of $100\,\mathrm{m}$. Is this enough to resolve the largest eddies? How does the definition of turbulence influence the interpretation of the results? The authors often talk about complete cloud glaciation, but what does that mean? The seeding plume has no LWC anymore? What is the definition of that?

- The case study description should be extended by more numbers already in the text. The authors say the seeding area was characterized by high RHs, from Figure 1a it looks like 50-60 $\%$, which in my opinion is not high. It is further stated that the cloud is decoupled form the surface, $500\,\mathrm{m}$, and with a cloud top temperature of -16 $^{\circ}\mathrm{C}$. Where is this information coming from? From Figure 2 I can only see that the radar reflectivity is low, i.e., that most likely it was non precipitating. The authors should avoid using the jet colormap (Figure 1, continuous or discretized) given the known issues with using that colormap (this goes for all figures having that colormap). I further cannot see the -16 $^{\circ}\mathrm{C}$ cloud top temperature given the scale only goes to -14.5 in Figure 1d. What is the reason for choosing such a large range given that most of the observed temperatures were in-between -14 and -12 $^{\circ}\mathrm{C}$. In Figure 1, is the pink area in a and b corresponding to the view in c and d? If not, it could help to do it that way.

- How do the authors define NOSEED and SEED areas? Why wasn't a simulation with no seeding used as a reference for no seeding effect? This is important to know, especially when the authors talk about the change in precipitation.

- A short description on the natural ice nucleation in the model should be done. What parameterization is active at these temperatures and how strong is the freezing to be expected? This should also be discussed in relation to the observed case, where basically no ice nucleation (low radar reflectivity) was observed. So, is it relevant to turn on ice nucleation in the model? This is also of importance to the discussion about the effect of turbulence on ice nucleation.

- Radar reflectivity and cloud thickness in the model simulations: Figure 5 shows a rather thin liquid cloud layer with strong seeding signals. I wonder what changed in the radar reflectivity in Figure 7 as there is a stronger signal in the seeding, but also from the background cloud? Also is the cloud thickening from 2:30 to 3:00 in Figure 7? I am further confused by the signal of LWC (cloud water mixing ratio) in Figure 8 as it appears to be more widespread than in Figure 5 (over more vertical levels). Am I confusing here something? A difference plot with a reference simulation (no seeding) could also be helpful to disentangle turbulence induced by the seeding plume and from the environment.

- Precipitation: The results are presented in a nice way, but I am missing a proper discussion on the significance of the simulations (i.e., uncertainty) and especially the scale is omitted in the text. The figures show a scale of 0.1 $\mu\mathrm{m\,h^{-1}}$ of changes in precipitation? Also here the computation of the differences in SEED and NOSEED should be made clear (see comment above). Figure 11: the boxes seem to be of different sizes and I am wondering what the numbers in the text really tell me given that the colors show the precipitation and not total water volume.

Minor comments

- Line 17: the acronym LESs does not have to be introduced as it is not used in the abstract
- Line 18: “the model can reasonably capture” - is there a word missing? reasonably well?
- Line 29: “similar crystal structure” to “similar molecular lattice structure”
- Line 30: Here the onset freezing temperature for AgI should be stated and also other references, such as Marcolli et al., 2016 and Chen et al., 2024 should be included.
- Line 41: What is the result of complete cloud glaciation? The decrease in cloud top and complete cloud clearing? Again here the definition of complete cloud glaciation is needed. I further do not understand the second part of the sentence, is the mixing consuming water or is it producing more through cloud droplet formation / growth?
- Line 59: definition of plains should be stated earlier, as it is already used before in the introduction and in the abstract
- Line 63: The formula by Korolev and Mazin is later used, maybe this can be pointed out here, otherwise this reads as a rather random information. This also can be said for the next sentence, regarding the findings by Korolev and Field (2008). What are the authors trying to convey with this information? How is this relevant for their study?
- Line 68: the introduction of LWC is good and should be used throughout the manuscript (instead of liquid water and cloud water mixing ratio). This way, it is consistent and will help ease the understanding.
- Line 70: Does “suppress this through cloud top entrainment” refer to ice growth or / and precipitation?
- Line 79: I think it is valid to conduct the study over flat lands, but the authors say it is also relevant to mountainous terrain. Here, more justification for this interpretation would be great.
- Line 91: already here the cloud type (i.e., stratiform) can be defined.
- Line 156: Where is the sounding coming from? Is this a real observation? Or did the authors prescribe an artificial profile (also fine)?
- Figure 3: Can you add the RH profile, such that the conditions are more easy to grasp? Especially when you talk about dry intrusions from above, this could be helpful instead of having to do the calculations oneself.
- Line 203: What is the resolution of the radar?
- Line 206: A reference to Omanovic et al., 2024 should be done, given that they reported a similar result with too slow WBF process.
- Line 241: “scales of seeding plumes”? Do you mean the vertical extent? The spread?
- Line 260: What do you mean by similar variations? In terms of magnitude? Pattern?
- Line 265: I believe difference plots between the simulations would help here the discussion, as the difference can be quite subtle and I cannot follow the discussion of the authors on the changes.
- Line 275: I understand if you do not want to dive into riming and aggregation, but could you provide more information on that? Maybe an appendix figure? Riming and aggregation should occur especially with these high ice concentrations.
- Line 279: I believe there is a word missing before “became lower ...” or what do the authors refer to? The deposition rate?
- Line 309: enchantment to enhancement?
- Line 362: I might understand Figure 12 wrong, but enhanced turbulence does not enhance both cloud glaciation and turbulent mixing. I mostly see a reduction in the time for cloud glaciation, while for turbulent mixing this is more difficult to see. Maybe a quantification could be helpful here.
- Figure 13: How can you have negative condensation rates (evaporation) with vertical velocities larger than w^*? Can you quantify how often you encounter which conditions, i.e., both growing or only ice crystals growing?

- Line 397-401: this is one sentence, can you split it up?
- Line 414: There are other (older) reference to ice crystal growth across temperatures, please add them.
- Line 417: Nimbostratus produce natural precipitation. Why did you choose this cloud type as an example? Is it really ideal to be seeded?
- Line 448: What ways do you see to parameterize turbulence in connection to cloud microphysics? Are there open questions in this regards?

References

Chen, J., Rösch, C., Rösch, M., Shilin, A., & Kanji, Z. A. (2024). Critical Size of Silver Iodide Containing Glaciogenic Cloud Seeding Particles. *Geophysical Research Letters*, *51*(7), e2023GL106680. https://doi.org/10.1029/2023GL106680

Marcolli, C., Nagare, B., Welti, A., & Lohmann, U. (2016). Ice nucleation efficiency of AgI: Review and new insights. *Atmospheric Chemistry and Physics*, *16*(14), 8915–8937. https://doi.org/10.5194/acp-16-8915-2016

Omanovic, N., Ferrachat, S., Fuchs, C., Henneberger, J., Miller, A. J., Ohneiser, K., Ramelli, F., Seifert, P., Spirig, R., Zhang, H., & Lohmann, U. (2024). Evaluating the Wegener–Bergeron–Findeisen process in ICON in large-eddy mode with in situ observations from the CLOUDLAB project. *Atmospheric Chemistry and Physics*, *24*(11), 6825–6844. https://doi.org/10.5194/acp-24-6825-2024