

# Response to Referees

Glaciogenic seeding-induced hole-punch clouds and their sensitivity to the clouds' background state

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Dear editor and referees,

We would like to thank the editor for handling our manuscript and the referees for their careful evaluation of the revised manuscript. Below we address our detailed responses to all the comments. In this response-to-review document we try to clarify and address each of the suggestions, comments, and questions made during the review process. Therefore we have copied the comments in lavender boxes and have addressed them one by one. In the response we use italic fonts to quote text from the revised manuscript. Additional to the revised manuscript, we have uploaded a version of the manuscript with highlighted tracked changes.

Best regards, Nadja Omanovic et al.

## Response to referee #1

### Comments to the Author

The authors have worked on clarifying the setup and modelling strategy. After some final minor comments I would suggest publication.

We thank the referee for taking the time to re-review our manuscript and the constructive comments. We will address the concerns below.

### Specific Comments

**Comment to GC1:** I look forward to see future work! Perhaps the CCN concentration used for the simulation could be mentioned in the setup for reproducibility?

Thank you, this is a valid point and we added to the model setup description, that the background CCN concentration is set to  $1000 \text{ cm}^{-3}$ .

**Comment to GC2:** The added description of the Smagorinsky constant is now more clear as well as the choice of perturbations. Line 130 could still use a statement on the choice of 0.3 (as in  $0.23+0.7$ ) to better clarify the selection. Is there a reason for the chosen default value in the model?

We extended the justification for 0.3. The chosen default value is based on investigations by Dipankar et al., 2015. They found that  $C_s \approx 0.2$  gives the best results in terms of resolving boundary layer eddies.

**L53** “How is the ‘void of ice crystals’ requirement upstream from the field site ascertained in the experiments?” The given explanation does not quite answer my question. Likely the main reason why these clouds are cloud ice free is the temperature, INPs would be present in any case but most likely the INPs present, due to the warm temperatures, do not activate. So the newly added sentences are a bit misleading as the authors haven’t shown any INP measurements. Furthermore, the original question was rather in regard to the prerequisite that the clouds should be cloud ice free before seeding, how is this investigated or do the authors rather assume that the cloud state is constant as mentioned in L70? Perhaps a sentence on this would be useful.

Apologies for misunderstanding the question. In the mean time, an article emerging from the CLOUDLAB data set was published investigating how the INP concentrations change during the low-stratus conditions in Switzerland. We added this reference to support our argument that the INP concentration is low at the main field site, and thus we can expect ice-free clouds. We now stated explicitly that the low ice nucleating activity makes these clouds suitable for seeding. Furthermore, our Figure 1 shows that before and after seeding no ice crystals are present in the.

**L80** “Furthermore, ice crystals were measured only during the seeding signal,…” Makes it sound like they were only measured during seeding, I think what the author’s are trying to convey is that ice crystals were only present in the measurements during the seeding.

Thank you, this make it cleaer and we adapted the sentence accordingly.

**L131** “The possible impact of subgrid-scale mixing on clouds was examined for variety of cloud types.” “has been” instead of “was” and “a variety”

Thank you, we adapted it as suggested.

**L135** A bit too colloquial language; “we want to investigate if we see”. Perhaps rather; “By varying Cs across a widely accepted range of values, the impacts on the WBF efficiency are explored”

Thank you, we changed the sentence.

**L144** I should have commented on this in the previous draft, but how do the authors ensure that the reduction in LWC is not due to other microphysical processes such as riming, aggregation, and rain formation?

Our investigations in previous CLOUDLAB studies showed that the aggregation and riming rate, both contributing to rain formation, is low. We cannot exclude it fully but its contribution is minor. We added a statement in the Model Setup and Simulation description.

**L202** “both found a strong dependence of simulating glaciogenic cloud seeding on horizontal resolution.” swap the order; “both found a strong dependence on horizontal resolution when simulating glaciogenic cloud seeding.”

Thank you, we changed the order.

**L123** “3D turbulence parameterization (Samgorisnky, 1963”

Thank you, this is corrected now.