Authors' comments to Editor's comment to Anonymous Referee #2

We selected below the comments highlighted by the editor and added the corresponding changes in the manuscript.

L65: Why "on the statistical significance"?
Given the natural variability in cloud systems, it is difficult to assess the feasibility of cloud seeding in an experimental setup. Here, numerical weather models can help to assess the uncertainty of cloud seeding by conducting repeated seeding simulations.
We added the following to the manuscript (line 68): "*Complementary to such field experiments, numerical models are employed to shed light on the statistical significance of cloud seeding by conducting repeated simulations in a controlled setup, which is not possible in a field experiment.*".

L187: "The seeding plume was defined ..." If the seeding plume is defined by a threshold, why did the authors still need the unseeded simulation as the background?
We need an unseeded simulation (reference simulation) to identify the changes in, e.g., cloud droplet number concentrations and vertical velocities for the grid cells affected by the seeding and not elsewhere in the model domain.
We added the following changes to the manuscript (line 209): "*We applied a simple method to extract the seeding signal from the background. We took the difference in ice crystal number concentrations between a seeding simulation and a reference simulation (no seeding) to remove the background and isolate the seeding plume. The seeding plume was then defined by a threshold ice crystal number concentration of 0.001 cm−3. We used the identified seeding plume as a mask for extracting further quantities in the seeding simulation, but also in the difference between the seeding and reference simulation, such as cloud droplet number concentrations, temperature, and updraft changes caused by the seeding perturbation.*".

L194: There are a few issues in Section 3.1. First, both Figures 3 and 4 showed that the temperature range where the seeding occurred was suitable for secondary ice production. Is this process parameterized in the model? Does it have an impact on the results? Second, the use of Jan. 26 as a testbed for Jan. 25 and then comparing the simulation results with Jan. 25 observations is questionable. Even though the seeding height is adjusted to match what actually occurred on Jan. 26, the meteorology for Jan. 26 seems to be different from Jan. 25 (cloud temperature range, thermodynamic profiles, maybe also liquid water content profile, etc.) Please carefully justify this decision.
Secondary ice production is simulated in the model following Hallet and Mossop. However, it only occurs if graupel or hail particles are rimed, and then a splintering rate is calculated. In our simulations the amount of graupel particles is close to 0, so we do not see an effect of SIP.
We added following to the manuscript (line 176): "*At subzero temperatures secondary ice production can occur, which is also parameterized in the model. For secondary ice production to occur in the model rimed graupel particles are needed, but their concentrations are close to zero in the model; hence we can exclude the effect of secondary ice production in our analysis*".

Given that the model simulation from 26 January 2023 reproduces the cold temperatures from 25 January 2023, without the sharp inversion at cloud top, we believe it is adequate to use the 26 January 2023 simulation as a testbed. While we do have a lower cloud on 25 January 2023, we still encounter a persistent low stratus cloud with north-easterly to easterly winds as shown in Table 1. The wind speeds are comparable in the observations and the model, and this further supports our method to use 26 January 2023 as a surrogate model.
We added the following to the manuscript (line 182): "*The selection of the presented seeding simulations was constrained by how accurately the model reproduced the observed environmental conditions. Unfortunately, the model overestimated the temperatures for 25 January 2023 (Henneberger et al., 2023) (Fig. 3a), while the temperatures on the 26 January 2023 were simulated adequately (Fig. 3b). For this reason, we decided to utilize the simulation of 26 January 2023 for all seeding experiments conducted on 25 and 26 January 2023 (see also Sect. 3.1) given the presence of persistent low stratus clouds with north-easterly to easterly winds on both days.*".

L209: "predicted cloud cover": How did the authors define cloud cover from radar observations and simulations?
The reflectivity of the cloud radar (FMCW-94-DP, Radiometer Physics GmbH) is used as a proxy for cloud cover observed at the field site. In the model, the cloud cover is diagnosed based on the prognostic cloud water mass.
We added the following to the manuscript (line 243): "*In addition, we compared the observed and predicted cloud cover at the field site by taking the radar reflectivity of a vertically pointing radar as a proxy for cloud cover and the computed cloud cover from the prognostic cloud water mass in the model (Fig. 4).*".

L235: How is radar signal simulated? Did the authors use a radar emulator? Please describe.
Yes, we used a radar emulator, which is based on an existing diagnostic inside the model source code. This diagnostic is based on a Rayleigh approximation for the backscattering of the hydrometeors, where for frozen hydrometeors it differentiates between dry and wet ice, snow, and graupel. The diagnostic takes the prognostic cloud masses into consideration and calculates the reflectivity.
We added the following to the manuscript (line 270): "*The simulated radar reflectivity is based on an implemented Rayleigh approximation for the backscattering of the cloud particles, where for frozen hydrometeors it is differentiated between dry and wet ice, snow, and graupel.*".

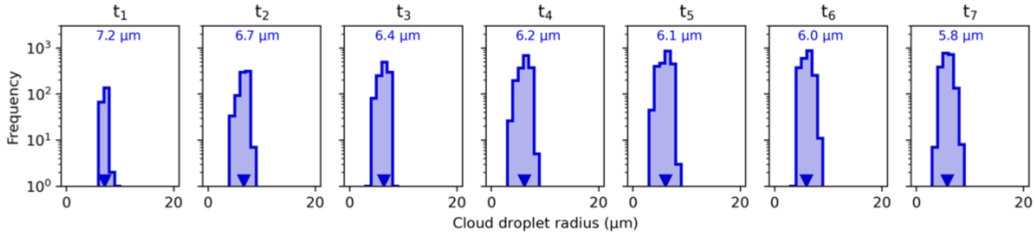
L278: "emphasizing the high efficiency of the WBF process": Is it possible to be secondary ice production?
We assume that the rate of secondary ice production is low as we only have very few larger cloud droplets (with radii > 20 μm) and riming only occurred in 2 of the 5 experiments (S26-2.5a/b). Given that the ice crystals only had a short time to grow (6-9 min) the splintering process occurs probably rarely, and if it does, these splinters did not grow large enough in that short amount of time to be detected in HOLIMO.
We added the following to the manuscript (line 178): "*During the field experiments, we also expect a low secondary ice production rate given that only a few larger cloud droplets (with radii > 20 µm) are present. Riming on the ice crystals was also only visible in two out of the*

five experiments (S26-2.5a/b). In addition, if splinters occurred, they probably did not grow large enough to be detected given the short growth time during the experiments (see Table 1).".

L317: There are a few issues regarding the results in Figure 10. First, please clarify the data points going into the third and fourth rows (ice and liquid size distributions). In particular, is the integral of the area below each distribution the same as the total number of grid boxes in the plume? Second, due to the sedimentation of ice particles, the ice and liquid size distributions are for different particles and cannot be directly linked. Third, it seems that the main result is that at t2, (1) the observed ice particles are bigger than those in the simulations and (2) the observed liquid droplets are smaller. If one believes these two facts are linked, it is consistent with a weak WBF. But there could be many reasons that these two discrepancies are caused by different factors. Why can it be attributed to WBF? Fourth, if the main indicator of WBF is cloud droplet depletion, then all the data points contributing to the distributions in the fourth row are from grids that are less or not affected by WBF and these distributions do not support the argument anyway. Fifth, how do the liquid size distributions in the plume compare with background size distributions in the model? Sixth, the first two rows are interesting. Is there any dynamical factor that could lead to ice being too small and liquid too large? Like, does the vertical velocity distribution compare well with the observations? Does the release of the latent heat from seeding create its own circulation? This may affect the "background" cloud properties. There are some papers on this, for both marine stratocumuli seeded by ship emissions and mixed-phase clouds or supercooled liquid clouds seeded by ice, IIRC. Seventh, it seems that the distributions of the updraft vs the downdraft in the second row are inconsistent with those inferred from the first row (i.e., if one naively assumes the line between WBF_up and WBF_down separates the updraft and the downdraft). Is it simply because the vertical velocity in the cross section is not representative of the whole plume volume? Please clarify.

(1) We added in the figure captions that the radii calculations are based on the tracked plumes: "*Third row ((o)-(u)): Frequency distributions of equivalent ice crystal radius (µm, pink) over time and mean equivalent radius (downward facing triangle, pink numerical value) for the seeding plume at every model output time step.*".
(2) We further constrained the tracked plume in the simulation by the available cloud water mass which leads to a more focused investigation of the WBF process inside the cloud. This way we can assume that in the model and in the observations the seeding effect inside the cloud is compared. We added the following in the manuscript (line 330): "*In addition, we constrained the seeding plume by the available liquid water content inside the cloud: We only considered grid cells in the analysis where the ice crystal number concentration is larger than 0.001 cm^{-3} and the liquid water content larger than 0.1 gm^{-3}. This way we only include grid cells where the WBF process actually could take place.*".
(3) We would argue that the cloud droplets in the model and observations have similar mean radii, while the ice crystals show a larger discrepancy, which can be attributed to the WBF process.
(4) The grid cells going into the analysis of the fourth row are selected based on the plume with a ICNC threshold of 0.001 cm^{-3}. Hence, in all grid cells where we encounter cloud droplets, we also encounter ice crystals, which allows for the WBF process to take place. See also answer to point 2.

(5) The cloud droplet size distribution for the background state of the model (see figure below) shows a higher mean size for all plume time steps. Hence, we have a reduction in cloud droplet size when we introduce ice crystals via seeding. We added this figure to the appendix and reference it here in the text (line 375): "*Also the mean radius of cloud droplets in the reference simulation is consistently larger than in the seeding simulation (see Fig. D1).*".



(6) 1st and 2nd row: Unfortunately, we do not have any observations on vertical velocities for the whole model domain. We cannot disentangle between the microphysics and dynamics influencing the growth of ice crystals / evaporation of cloud droplets. This is subject to future studies. The effect of the latent heat release from seeding is under debate. In Henneberger, Ramelli et al. (2023) it was discussed that some part of the updraft could be invigorated by the latent heat release. We added the following to the manuscript (line 372): "*We note here, that we cannot distinguish between the microphysical (latent heat release) and dynamical (topography and wind field) influence on ice crystal growth and evaporation of cloud droplets. Henneberger et al. (2023) discussed that some updraft invigoration may occur due to latent heat release upon ice nucleation, however this is still under debate*.".

(7) The vertical velocity cross sections are snapshots, and not averaged contour plots, that aim to highlight the dynamic structure of the cloud over time. In the WBF analysis (first row) all vertical velocities inside the plume were analyzed. We added the following to the figure caption: "**Figure 10**: […] *Second row ((h)-(n)): Cross sections of vertical velocity (instant values) along the mean wind direction over time.*[…]"

L334: Section 3.3.1: It is well-established that spherical ice particles do not grow fast enough, compared with ice particles with extreme habits. In the temperature range during the two days, the ice particles are likely to be needles/columns. Testing the effect of ice habits is probably more meaningful than increasing seeding rate by brute force.

It is true that spherical particles grow slower than other habits. However, in this study we wanted to investigate how the ice crystal growth in the current Swiss weather prediction model is represented. Additionally, various different modelling studies that have showed either a too strong or too weak WBF process, have all assumed spherical ice particles in the microphysics schemes (see Introduction). We do agree that the shape of the ice crystals is the next step to be investigated, and this will be done in future studies.

We added the following in the manuscript (line 168): "*The ice crystal shape is set to be spherical, which is a simplification in the scheme given the large variety of shapes (Bailey and Hallett, 2009). In this study, we do not change the shape of the ice crystals as we want to investigate the ice crystal growth rate in the default configuration of the model. During the conducted seeding experiments, we mostly measured needles or columns. When we compare the ice crystal sizes in Fig. 10, we investigate the mean equivalent radius of ice crystals.*".

Within the manuscript text, please more directly address the reviewer concern regarding potential mismatch between the observed and modeled arrival times (or indicate where that has been done).

We added following to the manuscript (line 156): *"The frequency of model output was set to 5 min after also testing1 min output frequency, which showed similar results as in the 5 min output. Moreover, calculating the expected arrival time of the seeding plume at the field site (seeding start and growth time, see Table 1) shows that the expected arrival and a full 5 min model output timestep are very close (within ± 1 min)."*