Answer to Anonymous Referee 3

The authors are grateful for the time and thought that Anonymous Referee 3 put into the review and comments regarding our paper. We incorporate most of those comments into our revised manuscript, which has led to substantial improvements. Detailed responses to all comments follow below. The original comments from Anonymous Referee 3 are in italics and our responses in plain text.

In this study the authors investigated the influence of input data uncertainties on the simulated cirrus cloud properties over Jungfraujoch using a microphysical trajectory box model. They looked at the impact of trajectory resolution, unresolved updraft velocities, and the assumed IN number concentration on the simulated accuracy. Not surprisingly, they found higher trajectory resolution and the addition of small scale temperature fluctuations helped to improve the agreement between model and observation. On the other hand, the higher sensitivity to the specified initial humidity than to the unsolved temperature fluctuation is interesting. My major comment is that the observational data (lidar retrievals) used to the evaluate the model result are too limited in time (20min). This made the case study too specific and perhaps not applicable to other conditions. In general, the paper is well written and easy to read. However, I agree with reviewer 2 that the information presented in figure 10 is not very clear and should be improved. Some of the figure indices are mismatched and need to be carefully checked before final publication.

The representativity was addressed by Reviewer 1 as well. In the manuscript we emphasize that our results may not be representative for all atmospheric conditions. To examine further atmospheric conditions, the more active case in the Appendix was added. We have additionally performed simulations for different times during 2011-11-22, with similar results as those presented in the manuscript. Therefore we presented only the results of the chosen time slot. A discussion on this issue was added in the Conclusions.

Specific Comments:

P7536L18: Typo "bysignificantly"

Done

P7537L11: Remove "in turn"

Done

P7540L3: Would be better to note that the reported IN concentration in DeMott et al. (2010) is in per standard liter, not per liter under the ambient state. What's the unit (L-1 STP or L-1 under ambient state) used in the IN sensitivity simulations?

This has been noted in the manuscript. Our unit used in the simulations is in 1 per volume of ambient air.

P7541L22: How does ZOMM represent the size distribution of ice particles?

ZOMM uses a log-normal size distribution. It is initialized with 100 logarithmically spaced size bins. The number and radius of each size bin is allowed to change during the model run. We added this information to section 2.3. For further details we refer to the work of A. Cirisan, 2014 (cited in the manuscript).

P7542L16: Why only 20min's data were used? Why not using more lidar data and including more trajectories in the analysis?

We chose this time window because we manage to hit Jungfraujoch with a sufficient number of online trajectories at this time and because the underlying NWP-model produced a cirrus cloud at this time. We therefore assume that the NWP-model correctly models the larger scale temperature and moisture field at that particular time, so that we can rely on the *p* and *T*-fields that we need to force the microphysical box model. We have analysed different time windows on this day. Since the results did not differ significantly for other time windows, we decided for brevity to only show the results for this particular time. In addition, it has to be considered, that for each trajectory type (20 s, 1 min, 5 min), we performed 25*21=525 different simulations, adding up to a total of 1575 boxmodel runs.

P7544L24: If more trajectories were included, do you expect the result would change?

If including more trajectories for the same case, we would not expect to see major changes in the results as to the sensitivity of the simulations to initial moisture, cooling rate statistics or IN number density. The major reason is the fairly homogeneous large-scale situation during this period. If the same analysis would be conducted for other case studies, we expect somewhat different results, particularly in the relative importance of uncertainties in the small-scale temperature fluctuations and other variables. However, we anticipate that the simulations will be still sensitive to all of the parameters.
We would like to highlight again that a more general assessment of the relative uncertainty for a variety of different large-scale situations is beyond the scope of the current study, as the number of required box-model simulations is quite significant and the calculation of online-trajectories – ensuring a suitable coverage- is quite demanding.

P7544L11: What is the number of solution droplets assumed in the model?

We assume 250 sulfate particles per cm^3. Their sizes are distributed log-normally with a mode radius of 0.05 micrometers and a sigma of 1.4.

P7545L13: "according to the formulation of : : :" this part is a bit misleading.

We reformulated this sentence.

P7545 section 2.3: more details of the ZOMM model are needed. For example, apart from the nucleation process, which other processes are considered in the model? How these processes are coupled? And what is the microphysical time step?

ZOMM takes uptake and release of water vapour by ice crystals as well as solution droplets into account. In addition, sedimentation of ice crystals is treated. We added the time step scheme in the manuscript: "In the model, we apply a dynamic time step. The composition of liquid solution will change maximal 0.1 % in the nucleation regions and 1% for other regions during one time step."

We included this information in section 2.3. For more details on the of the ZOMM model we refer to section 3.4 in the paper of A. Cirisan from 2014.

P7545L18: Offline trajectories are based BACKWARD calculation, while the online trajectories are based on FORWARD calculations. Will this make a difference in the box model simulations?

No this will make no difference at all. If only the grid-scale wind field is used (as in the present study) and turbulent motions are not explicitly taken into account, trajectories calculated forward or backward in time will have an identical path, if the forward trajectories are started from the location at which the backward trajectories end (or vice-versa). Therefore also the evolution of temperature and pressure along the trajectories will be identical and hence the information that will be used by the boxmodel. The microphysical box model is run forward in time for all trajectory data-sets. We included the later information in section 2.3 of the paper.

P7545L19: Could you elaborate more about the sedimentation treatment? The current statement is not clear to me. Do you take the sedimentation flux from the host COSMO model? If so, do you consider the same ice particle size distribution in COSMO and in ZOMM?

No, we do not use the sedimentation flux from COSMO. Sedimentational fluxes to lower parcels are based on ZOMM simulations along higher level trajectories. We reformulated the respective sentences in section 2.3.

P7555L7: Do you mean Fig.8 here?

Thanks for the hint. We mean Fig. 9 but the correct color on line 6 should be blue.

P7555L12: Doesn't the green curve in fig8a indicate a cloud?

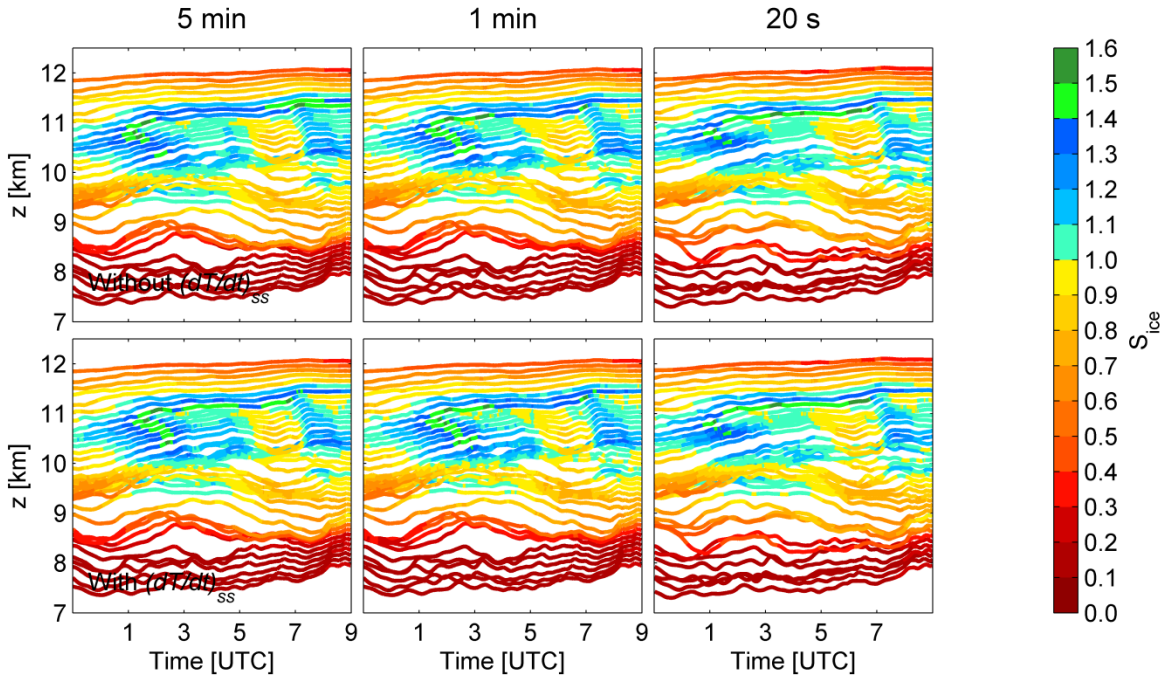
It indeed does. In lines 10 and 13 it should be Figure 9 instead of 8. Please excuse for the confusion.

P7556L1: Do you mean Fig.8c?
No, 9c

P7556L24: Do you mean Fig.8a?
Yes

P7557L21-228: The discussion here is a bit hand-waving. Would be nice to plot the supersaturation (as figure 6 and 7) before and after the microphysical calculation and the ice crystal size to facilitate the discussion.

We provide the supersaturation figures below. We do not think that there is a need to include those figures in the paper. However, we reformulated this paragraph in the article to be more precise.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