Manuscript entitled „Application of holography and automated image processing for laboratory experiments on mass and fall speed of small cloud ice crystals" by M. Weitzel et al.

Once again, we would like to thank the reviewer for the useful comments and suggestions which helped to improve the manuscript. The reviewer's comments and questions were answered in the following; comments or questions are written in bold font, our answers in standard font.

"There are other ´experimental´ studies of velocity of small ice particles in chambers e.g. those cited in Westbrook paper you mention (which are quite old) but also the more recent work by Argentinian group […] It would be very useful to put you work in context against those other studies"

In their work, the Argentinian group Bürgesser et al. studied the fall behavior of hexagonal planar (Bürgesser & Castellano, 2017) and column crystals (Bürgesser et al. 2016) by determining and relating Best- and Reynolds numbers. We have compared our results to the results of the latter study in Section 4.3 and Figure 9. This comparison indicated that the parameterization of Bürgesser et al. predicts significantly higher Best numbers than our experimental results.
As our experiments did not include many hexagonal planar crystals, we were not able to accurately establish whether our observations agreed or disagreed with the findings in Bürgesser & Castellano (2017).

"It might also be cold enough to nucleate ice homogeneously from vapour if there is flow of warmer air past this rod?"

Because of the large number concentration of ice crystals homogenously nucleated from droplets present in the air flow, we expect the pathway of homogenous nucleation to be negligible in this setup. The copper rod is kept at this very low temperature only for a limited time before it is flushed with warmer air. During this limited time of cold finger activation, the droplet supply is not expected to be depleted, thus crystals nucleated from droplets are always present. Supersaturations high enough to trigger homogenous nucleation from water vapour are thus very unlikely to be reached due to the preferred pathway of diffusion of water vapour towards the preexisting crystals.

“You could be more specific here. Do the points [Fig. 3b] outside the grey line tell us about the accuracy of the velocity estimates?”

The uncertainty of the velocity measurements themselves is significantly smaller than the spread observed here. The spread is thus a result of a superposition of the residual turbulence in the chamber and the accuracy of the velocity estimates.

“Are you able to match mass and diameter estimates from the particles on the slide to the corresponding velocity measurements of the particles in the tube? Or are you characterizing the average mass of similar crystals at around the same time (and what random error does that introduce?)

The concept of matching individual velocity measurements to mass measurements was considered during design of the experimental setup. The final setup, however, only allows for the comparison of ensembles of mass measurements to ensembles of velocity measurements, as the focus of this study was to maximize the number of individual m(D) and v(D) data points. The connection between our findings for mass and velocity can only be made by comparing the distributions of particle masses and the distribution of fall velocities measured during the same experiment.

This fact has been reemphasized in the corresponding text section of the revised manuscript in Section 3.2, lines 177 and following.

It shall be noted that this response has been repeated for the answer to a comment given by reviewer #3.

“I think it would be very useful to estimate the Reynolds number of the particles somewhere. Then you can establish the extent to which we should expect to be in the Stokes regime, as a function of D” […]

The Reynolds number of the observed crystals ranged between 0.1 and 0.7 (see Fig. 9). The observed fall behavior is thus not clearly in the Stokes regime (where Re would be << 1), with turbulence showing a minor impact on the observed fall velocity. A note has been added in line 307 and the following in the revised manuscript.

“In the Stokes regime it is surely not possible for $D_{hyd} > D_{max}$, but D_{maj} is not equal to the maximum span I suppose (how does it relate?) and perhaps at D_{maj} = 100 microns are you moving out of the Stokes regime?”

The description of ice crystals with respect to their maximum span D_{max} was never intended in this context, and the text and figures have been adjusted accordingly to correctly always use D_{maj}.

D_{hyd} is calculated from Equation 9. The mass power law relation given in Section 4.2 is applied to parameterize m on the right side of the equation here, which introduces two sources of error. Firstly, the parameterization is determined for the area-equivalent diameter of the crystal contour, D_{ae}, but applied to the long axis of an ellipse fit around the particle contour D_{maj} and thus not applicable strictly without error in this context. Further, the mass parameterization is most strongly determined by ice particles with sizes around 60 µm and, as evident from Fig. 5, mostly overestimates the mass of crystals with D > 100 µm. This overestimation of m also leads to an overestimation of D_{hyd} for those larger crystals. We thus do not expect that $D_{hyd} > D_{maj}$ would be observed for any crystals in individual measurements, but rather an asymptotical approximation of the fit to $D_{hyd} = D_{maj}$.

The relationship between D_{hyd} and D_{maj} proposed in this work is thus expected to accurately describe crystals with D_{maj} < 90 µm. For larger crystal sizes, more data would be required to either determine a new parameterization or adjust the one given here to be more accurate for all D_{maj}.

"Meaning is not clear – what is correlated with what, and how?" *(Re: Line 261 in the original draft, "Crystal habit and size show good correlation, as most crystals with D_{maj} < 70 µm have grown with a columnar or irregular habit, […]")*

We observed that none or very few of the observed columnar or irregular crystals grew to sizes D_{maj} > 80 µm. Most of the observed crystals between 80 and 200 µm were of dendritic shape or aggregates crystals, which is why we concluded a correlation between crystal size and habit in our observations. The text section in line 287 has been adjusted to be clearer.

"Re-X relationships: the authors could go a lot further in analysing the accuracy of parameterisations/theories, e.g. Mitchell 1996, Böhm 1989/1992, and Heymsfield and Westbrook 2010. You seem to have all the data to do this. Why not?"

We focused on the development and description of a new measurement technique for determining the properties of ice crystals in the size range smaller than 150 µm. While comparisons to related studies are important for understanding the context of this work's results, and have thus been conducted and described in Section 4, further analysis of the accuracy of other parameterizations is beyond the scope of this paper.

"I think the paper would greatly benefit from (i) more consistent use of characteristic length scale throughout, (ii) more explanation in the text of the rationale for picking a particular D for a given analysis or plot."

We incorrectly mentioned the particle maximum diameter D_{max} as the considered characteristic length scale in Figure 7 and the following text. These errors have been corrected, as D_{maj} is used for every aspect of this work where the results from holographic particle tracking are discussed.

To further clarify the usage of different characteristic length scales, Section 3.3 has been expanded to explain more clearly which formulation is used where and why.

“Consider providing data as a table / text file, as supplementary material?

We chose not to directly attach our data to this publication, as the data set is too large for convenient viewing. A publication on a suitable platform is planned at a future date. Nevertheless, all requests for our experimental data are very welcome and we are going to provide them for further scientific use.