Many thanks to the reviewer for his/her valuable comments and suggestions, which we have addressed as follows (the reviewer's comments are in italics, our reply is in blue standard text):

Anonymous Referee #1
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Major comments
This paper discusses data from the SID-3 and PPD-2K instruments, collected in three different environments, as a means of assessing the mixed phase state of a cloud. The work presented in this manuscript shows promise for expanding our understanding of cloud probes that rely on the information obtained from forward scattering patterns, but there are some issues with the work as presented here.

First, the authors fail to properly acknowledge false ice detection with the SID-3 instrument. Yes probability of coincident particles within the trigger volume is low (as discussed on Page 6, Line 13) but there is an extended sensing volume in which you can still have coincident particles leading to falsely identified ice. This needs to be considered by the authors in the context of the observations.

We agree with the referee and adapted our coincidence considerations. However, the coincidence issue is different for the SID-3 and the PPD-2K. In the PPD-2K the sample flow is focused on the laser beam. We think that the considerations we performed for the PPD-2K are correct and assume that the referee agrees with them. With regards to coincident particle sampling of the SID-3 camera we modified the manuscript as follows.

In order to determine the FOV of the SID-3 camera we applied a forced trigger signal onto the camera and placed a particle on a non-reflecting glass slide. The glass slide was mounted on a x-y-z stage and moved in the SID-3 laser beam. The procedure will be subject of a publication which is currently in preparation (Schnaiter et al.). From these measurements we derived a sensitive area of the camera of 9mm^2. Using eq. 1c) we calculated the probability for coincident sampling as 0.04% to 7.03% for particle number concentrations of 20 to 300 cm^{-3}. A coincident sampling probability of 7% is significant however scattering patterns with artifacts (e.g. from coincident particle sampling by the SID-3 camera) were carefully crosschecked as part of the manual inspection of the patterns. We included the determination of the FOV of the SID-3 camera (page 5 line 13-16) and a new subsection (Sec. 2.3.1.) on coincident particle sampling by the camera, accordingly.
Furthermore we changed the discussion of the scattering patterns with artifacts.
In case of the CLACE 2013 measurements we included that the probability of coincident sampling by the SID-3 camera is 1% for n = 103cm^{-3}. Such values are reached during the presented CLACE 2013 case study (Fig. 13 d)). Thus this is an explanation for the observed number of artifacts (page 22 line 7-15).
When discussing the VERDI data we included that in the presented section of VERDI flight 7 (when the n ~ 100cm^{-3}), 0.21% of the SID-3 scattering patterns showed artifacts. This illustrates that the given theoretical values in Sec. 2.3.1. should be regarded as an

upper boundary for coincident particle sampling by the SID-3 camera. This can be found in the new manuscript page 23 line 4-8.

Second, the authors promise to present data on the shape and roughness of ice particles. The shape of observed ice was touched on in the Jungfraujoch data and FFT particle classification scheme but overall lacking. Additionally, data on particle roughness and what this tells us about the observed ice particles is non-existent.

In order to show more data of ice particle shape we included the information that in the MPC experiments at the AIDA chamber, most of the imaged scattering patterns were classified as irregular (89.9%) according to the classification scheme (page 20 line 6-8). The presented data from VERDI flight 07 shows the same structure in terms of particle shape (86% irregular) (page 23 line 2).
Ice particle roughness in general and in particular the section 2.3.4. on ice particle roughness was removed from the manuscript as it will be introduced and discussed in detail in an upcoming paper (Schnaiter et al. in prep.).

Third, the authors also promised an algorithm that can discriminate the phase of cloud particles. An FFT method is mentioned but no in-depth details on the method were provided. Without such information, or citing where their algorithm came from, it is hard for the reader to determine how well the transform is preforming and subsequent particle classification can be trusted.

Our criterion to discriminate liquid droplets and ice particles is the variance of the azimuthal (v_{az}) profile (Fig. 2). Our measure, $v_{az,}$ is similar to the asymmetry factor used in earlier studies (Cotton et al., 2010). We think that we adequately outlined how our algorithm determines v_{az} in Sect. 2.3, and how we discriminate liquid and solid hydrometeors based on v_{az} including a manual crosscheck in Sect. 2.3.3. We validated this method against measurements of the SIMONE instrument and the WELAS OPC at the AIDA chamber in Figs. 9, 10, and 11.
The FFT of the azimuthal profile is used for the shape determination of patterns that were assigned as ice particles. This is based on the work of Ulanowski et al. (2007) and Stopford et al. (2008). To give the reader an illustration how this method works, we have added a supplementary Fig. 1 and Fig 3) to the paper which depicts further examples of irregular and pristine ice particles and the Fourier transforms of Fig 1. of the manuscript. We think that our ice particle shape classification is trustworthy because we limit ourselves to discriminate irregular from pristine ice particles only.
The used algorithm was developed at KIT IMK-AAF and is written in LabVIEW. We hope that this information is sufficient to answer the issue raised by the referee.

Minor comments

Page 2, Line 23 – The Wegener-Bergeron-Findeisen process is really only applicable to water vapor limited cases. If this process is relevant for the observations presented here it should be stated as such.

We agree with the referee and do not have sufficient water vapor pressure measurements for all of our data thus we modified our statement to:
In the presence of liquid water droplets, ice particles are expected to grow rapidly e.g. due to the Wegener-Bergeron-Findeisen process. (page 2 line 23)

Page 3, Line 2 – It is also challenging to distinguish observe and classify small ice particles due to instrument resolution and sample volume.

We agree with the referee and added a sentence to the introduction when discussing - other instruments (page 3 line 7-10):
The resolution of such instruments is further lowered by the fact that the detection units are apart from the sensitive volume and that it is advantageous to probe a as large as possible sensitive volume.

Page 5, Line 6 – It was also my understanding that using a droplet generator to map out the sensing volume of a SID type instrument was not so straightforward due to the imaging optics and the extended sensing volume. Can you tell us more about the process? Also, were any coincidence studies done with this set-up? Such work would be of great use to the community. If so, specific questions are as follows - If the SID-3 is triggered by a particle, what are the effects of another particle in the extended sensing volume at various locations along the beam? Where, if at all, along the beam can a second particle pass and it's effects on the scattering pattern are negligible?

We agree with the referee and as mentioned above we have mapped out the FOV of the SID-3 camera by applying a forced trigger signal onto the camera and placing an ice analog crystal on a glass slide. Form thereon we calculated the coincidence probability. The further questions of the referee are indeed interesting and could be answered by direct coincidence studies. It is in principle possible to run two piezoelectric droplet generators which synchronously emit a droplet. If both generators were mounted on a x-y-z stage one could perform a detailed coincidence test. However, due to the dimensions of the injectors the procedure is not trivial, but we plan to perform such a test in the near future.

Page 7 (and page 11) – You promise an algorithm that uses roughness to discriminate particles but it falls through. Nowhere in the context of your observations is roughness or GLCM mentioned. Please add this information if you wish to mention roughness. If you do add particle roughness information to the studies presented here, further definition of the gray levels used would be of great use to the community.

We removed the particle roughness section (in the old manuscript Sec. 2.3.4). It will be the subject of a publication which is currently in preparation (Schnaiter et al.in prep.).

Page 7, line 9 – Can the q and I thresholds used here be related to saturation of the azimuthal segments used for scattered light detection of the earlier SID models?

Instead of the high resolution scattering patterns with roughly 500 x 500pixels = 250000pixels earlier SID versions record scattering patterns with up to 28 individual detectors. As saturated or dark pixels are expected to be distributed over the whole image we do not expect that the values for the SID-3 can be easily translated into values for older SID versions. Such conversion factors are beyond the scope of this work.

Page 7, Eqn 2 – Do you have a feel from this work whether Vaz or asymmetry threshold, used in Cotton et al. and Johnson et al., is better at discriminating between ice and liquid? What value of N do you use here? How does this compare with SID-2 and its 28 segment detector? Additionally, Cotton et al. noted that the asymmetry threshold for discrimination was dependent on cloud type. Does Vaz suffer from the same issue? Can you correlate what you've found with Vaz back to SID-2 data?

We expect that the higher resolution of the SID-3 compared to earlier SID versions leads to more information contained in the image. If the scattering pattern displayed in Fig. 1 b) would be recorded with a reduced resolution the azimuthal asymmetry would decrease. Thus we conclude that the higher the resolution of the scattering pattern, the better one can discriminate the phase of the particle. We added a corresponding statement on page 8 line 25-27.
The plots v_{az} vs particle size differ from experiment and between the instruments, which can be seen from Figs. 10 and 15 and supplementary Fig. 2. Thus v_{az} depends on instrument and cloud type. However, the phase discrimination is ensured in the presented work by a manual crosscheck.
Due to very different resolutions of the patterns we think that a link between SID-3 and older SID versions is hard to establish and was not done in this work.

Section 2.3.3 – The authors go through the trouble of defining ice particle classification, but they don't fully utilize this instrument ability. For instance, during the AIDA expansion what types of particles were observed based on scattering patterns?

During the mixed phase period of AIDA Expansion 46 (100s < t < 500s) the PPD-2K detected 532 ice particle scattering patterns. 10.1 +/- 1.5% of these patterns were pristine and 89.9 +/- 5.7% were irregular. During the presented period of the VERDI flight 7 the SID-3 detected 57 scattering patterns classified as ice particles, of which 14.0 +/- 5.2% were pristine and 86.0 +/- 16.7% were irregular. These numbers illustrate that the vast majority of ice particle scattering patterns detected in MPCs at the AIDA and in the field are irregular.
This information is included in the manuscript on page 20 lines 5-6 (AIDA) and page 23 line 1-2 (VERDI).
A significant amount of pristine ice particle is generated at the AIDA in pure ice clouds which are however not a subject of this work.

Page 18, line 21 – It is a shame SID-3 was not operational for run 46 and because of this I don't feel that the observations of PPD-2K alone are enough to demonstrate your *conclusion, "the presented technique enables the discrimination between liquid water droplets and cloud ice particles at the same optical sizes in a range of 5μm < Dp <50μm."*

We think that this conclusion is valid based on two arguments. The first is that during expansion 46 there were SIMONE measurements presented in Fig. 12. These measurements indicate the presence of a MPC in the chamber.
Secondly, the similar sizing and phase discrimination capability of the SID-3 and the PPD-2K was presented in AIDA expansion 27. This can be checked by comparing the panels c) and d) of figures 8 and 9. Form 250s < t < 400s the size bins (<10μm) with high number concentrations (yellow in panels c)) are dominated by liquid droplets (blue in panels d)). From 450s onwards both instruments detect only ice particles, which are predominantly larger in size. Thus the sizing of the SID-3 and PPD-2K is similar.
We think the coherent picture of phase discrimination at the AIDA chamber between SID-3, PPD-2K, SIMONE and WELAS supports our statement.