Review of
Ice particle properties of Arctic cirrus
by Veronika Wolf et al.

General comment:
In this study, arctic cirrus clouds are investigated, using measurements from balloon-borne instruments. The data from eight radiosonde ascents are investigated about shape, size and number concentration of ice particles. In combination with trajectory calculations, the formation pathway can be determined and the microphysical properties can be related to these pathways.

Overall, this is an interesting study using a very promising technique for the detection of ice particles on a very well suited platform; thus, this is an adequate and meaningful contribution to ACP. However, there are some issues which should be clarified before the manuscript can be accepted for publication. Therefore I recommend major revisions for the manuscript.

In the following I will explain my concerns in detail.

Major points

1. Definition of liquid origin and in situ formation not clear
   The study relies strongly on the recent developed classification scheme by Krämer et al. (2016), separating ice crystal formation pathways into liquid origin and in situ formed ice crystals. However, the definitions of these two types seem not to be correct from a thermodynamic point of view: liquid origin is characterised by formation at water saturation, while in situ formation occurs at conditions below water saturation. Please correct and extend the definitions in the manuscript accordingly, see also Krämer et al. (2016) or even Wernli et al. (2016).

2. Interpretation of data and scientific results
   While the measurements of the ice crystals show very high quality and seem to be quite interesting, the evaluation of the data is weak. It is not really, what the authors want to state with their results. Especially, the interpretation of the data concerning the different pathways is not clear. What is the story you want to tell? What did you expect for ice crystal shape, size and number concentrations for the different formation mechanisms? What is the result and how can this be interpreted? Is there any hint from theory to corroborate these findings (was it expected or surprising, and why?)? Invest more theory for the interpretation of the data and the presentation of the results. Finally, it would be nice to have figures of the profiles, at least in the appendix.

Minor points:

1. High speed measurements:
   Actually, high speed measurements have some other issues beside the problem of shattering, see e.g. the compression of air as indicated in the study by Weigel et al. (2016).

2. Classification of data partly manually/automatically:
   It is stated in the text, that the classification was carried out partly automatically. Please describe how this was done and which techniques were used.

3. Measurements with RADAR/LIDAR:
   What was the outcome of the complementary measurements of RADAR and LIDAR? Is there any additional value for the results/interpretation?

4. Listing of the different clouds in table 2:
   It is not clear to me, how the authors can count 4 clouds, because it seems that there are two adjacent layers, since the top layer of the first cloud (e.g. 5680m) is the same as the bottom layer of the next cloud. Please explain this interpretation.