Reply to comments by referee #1

We thank the referee for carefully reviewing the manuscript and for the valuable suggestions and comments.

Remark: The referee's comments are highlighted in blue. Figure numbers in the authors' reply refer to the figures in the original manuscript. New/changed figures are included at the end of the document. Snippets included in the revised manuscript are highlighted by an additional indent and quotation marks.

Line 3 on page 3: "150.000" should be "150,000".

Changed.

Line 17 on page 5: "Also AKM state" should be "Also AKM states". Or, should it be better to state "In addition, the AKM observations reveal".

Thank you for the hint, we changed the sentence:

> "The AKM observed the left and right sundogs with a relative frequency of 18% each, compared to 36% for the 22° halos."

Suggestions for future studies: 1. From the upper panel of Fig.4, the HaloCam system is capable of observing 46-degree halo. As correctly pointed out in the manuscript, the ratio of 22-degree halo to 46-degree halo contains rich information about ice crystal aspect ratio. Thus, it is suggested that the present study based on HaloCam be extended to analyses of 46-degree halo.

Thank you for pointing this out. Indeed observations of the 46° halo in addition to the 22° halo would further increase the information content on ice crystal properties. However, with this setup of HaloCam the 46° halo is very close to the edge of the image which makes an evaluation difficult. Currently we are testing another observation setup with the camera tilted upward so that the upper part of the 22° halo and the 46° halo are located inside the image. For changes see answer below.

2. Ice crystals in the form of individual bullets or bullet rosettes have been extensively assumed (based on some in-situ micro-physical property observations). These ice crystals produce a halo at approximately 10 degrees. Did the HaloCam system ever observe this type of halos?

With this setup of HaloCam it is not possible to observe a 10° halo since this viewing angle is just covered by the circular shade. To observe this type of halo the distance between shade and camera could be increased (the size should remain the same to shield the whole lens from direct sunlight). Depending on the dynamic range of the camera the simultaneous observation of the 10° halo together with the 22° or even the 46° halo on the same image (i.e. with the same exposure time) could be difficult. Since referee #3 raised a similar question, we included the following sentence:

> "In principle, HaloCam could also be equipped with a wide-angle lens to observe halo displays in a larger region of the sky, however at the expense of the spatial resolution."