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Comment on acp-2022-128

Ping Yang (Referee)

Referee comment on "Ice crystal characterization in cirrus clouds III: retrieval of ice crystal shape and roughness from observations of halo displays" by Linda Forster and Bernhard Mayer, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-128-RC1, 2022

This manuscript is a follow-up of Forster et al. (2017, 2020). Overall, this manuscript is well organized and clearly written. The technical method is sound and the results are reasonable and convincing. It is this reviewer's opinion that the manuscript is essentially acceptable for publication as is. Nevertheless, some optional minor revisions are suggested for the authors' consideration in the revision process.

Minor comments:

Ice crystals in cirrus clouds are not monodisperse. Moreover, various ice crystal habits/shapes may coexist in a given cirrus cloud. In the revised manuscript, could the authors please elaborate on the impacts of the ice crystal size and shape distributions on the results?

In Eqs. (1) and (2), the extinction coefficient is involved, which is a bulk radiative quantity. But the particle size distribution is not specified.

As stated in the second paragraph on page 3, the authors' previous findings confirm that 25% of cirrus clouds produce 22-deg halos. However, spaceborne observations seem to suggest that ice crystals in cirrus clouds are roughened, for example, as demonstrated by one year of POLDER/PARASOL observations (see, Fig. 15 in Yang, P., S. Hioki, M. Saito, C.-P. Kuo, B. A. Baum, K.-N. Liou, 2018: A review of ice cloud optical property models for satellite remote sensing, *Atmosphere* 2018, 9, 499; doi:10.3390/atmos9120499). It will be valuable if this manuscript provides insight to coincide the finding based on spaceborne observations with that based on ground-based observations.

Optional minor editorial revisions:

Lines 2-3 on page 1: change "making use of" to "using"

Line 4 on page 1: Change " … the retrieval of size and shape of randomly oriented crystals" to " … the retrieval of the sizes and shapes of randomly oriented ice crystals"

Line 12 on page 1: change "forward scattering part of the ice crystal optical properties" to "forward portion of the light scattered by ice crystals"

Line 13 on page 3: change "…retrieve ice crystal shape and surface roughness" to "…retrieve ice crystal shape and the degree of surface roughness"

Line 12 on page 4: change "To the authors' knowledge" to "To the best of the authors' knowledge".

Line 32 on page 4: change "Look-up tables (LUT)" to "Look-up tables (LUTs)".