

Response to RC1 (Anonymous Referee #3)

Revealing Halos Concealed by Cirrus Clouds

Yuji Ayatsuka

I would like to thank the reviewers for their kind and useful comments and constructive suggestions on our manuscript. We have modified the manuscript according to the comments as possible. The modifications in our revised manuscript are listed below.

Main comment

- *However, it remains unclear why this is even important, and there should be more explanation why this work is important in the introduction. It would also be valuable to discuss if the algorithm is then used to determine the kind of halo as well as ice crystal habits typically associated with halo types etc. As it is, the text leaves the reader wonder why even care about it, especially since the halo is dependent on sun and camera positioning.*

Thank you for the comment. I have added some descriptions and references to explain the importance of halo observations on photographs in the introduction and the conclusions. (Updated references are listed at the end of this letter.)

Line 11: It is in an situ and wide-area observation of ice crystals in clouds. For example, the difference in frequency of appearance between 22° and 46° halos suggests the ratio of pristine to non-pristine crystals in clouds (van Diedenhoven, 2014). There are also several studies ice crystals and halo observations (Lynch and Schwartz, 1985; Sassen et al., 1994; Um and McFarquhar, 2015; Sassen, 1980; 15 Lawson et al., 2006).

Line 31: ... and extract the appearance and intensity of halos. It is quite useful for observing and analyzing halos precisely through ground images.

Line 199: In processed images, halos, which are often geometrically shaped, are more easily detected by feature detection algorithms. The algorithm is useful not only for accurately observing the appearance of halos, but also to measure the intensity of halos by removing cloud contrasts.

Minor comments

- *Line 19: AOI is not explained*

I'm sorry for the malformed citation. I have revised the description and the citation.

Line 18: The author of the present study has developed a revised method, called autoBR, which was implemented in an image processing tool, named Atmospheric Optical Image Enhancer (Ayatsuka, 2022).

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- *Line 19: “differently weighted” - how exactly?*

It is described in the later section in the manuscript, so that I have added some words to mention it.

Line 19: In autoBR, the red and blue channels are differently weighted and the green channel is also referenced (details are described in Section 3).

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- *Equation (3): What exactly does the equal symbol with dots stand for? Many readers will not be familiar with that symbol since it's not commonly used (I have not seen it before).*

I used a symbol “equal with dots” (\doteq) for meaning “approximately equals”. I haven't known, but it is an East Asian local style. Thank you for pointing it out. I have replaced it with ' \approx '.

Equation (3): $g(L_R + L_M + L_H) \approx g(L_R + L_H)$

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- *Line 145: Why is “b” chosen depending on the pixel number of an image? Why not depending on the camera angle? If the camera angle is wider, there would be more variations in color across the image.*

Thanks for the important comment. I set the current value of parameter “b” only as a default setting to balance quality and processing time, and for the case when camera angle information is missing. As reviewer #3 mentioned, optimizing the parameter “b” according to the camera angle will bring better quality. I think how to optimize it is one of the future studies of this work. I have added two sentences to describe it.

added to after Line 146: If the camera angle is known, the value can be optimized using this information. How to calculate the best value for each angle is a future work of this study.

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- *Typos*

Thanks for catching these typos. I have corrected them all.

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