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Atmospheric Measurement Techniques Discussions

Interactive comment on "SegCloud: a novel cloud image segmentation model using deep Convolutional Neural Network for ground-based all-sky-view camera observation" *by* Wanyi Xie et al.

Anonymous Referee #1

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Dear Editor: I am sending my comments with my colleague's one. please check them.

Best regards, Referee

This paper describes a proposal and results of an analysis system to retrieve cloud information from sky images taken by all-sky-view camera using a convolutional neural network(CNN). As well known, clouds have important roles for climate change as well as weather forecasting. Under these scientific interest, this study has been performed and is interesting for cloud researchers.

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Discussion paper

The paper summarizes a method of cloud segmentation from all-sky-view images and results using the newly developed method, compared with other traditional methods. As a result, the authors advocate that the method is more superior than the traditional ones, especially about solar aureole regions. In the usual photos including direct sun image, the light around these areas may be saturated as well as the sun itself. In this case, these have no information about cloud. Therefore, the cloud segmentation around these areas might be subject to the training data. As viewing the sample images, there are some doubtful regions found around the sun in the original sample image for “Clear sky” shown in Fig.4a (First row). While these look like small clouds or reflected images of dome, the system judges these are no cloud. On the other hand, an original image to be analyzed is fused with ten different exposure-photos (P3, L28-30). By using such a technique, it has a possibility to include cloud information around the sun. However, the paper shows no description on this effect when analyzing it. If the accuracy of cloud segmentation is improved by using the technique, please discuss it more, especially for aureole areas.

In the paper, authors have cited a paper written by Tao et al.(2019) introducing all-sky-view camera. In the Tao et al.’s paper they have discussed the analysis system of cloud segmentation called the optimized U-Net, which looks like similar to the present SegCloud. Because several authors are overlapped with those of that paper and one is the leading author of the present paper, they should discuss the difference of both systems and analyzed results in this paper clearly. Also Tao et al.(2019) have described the new database created for the system. This database must be the same as in this paper. Therefore, in this paper they should write “This database has been used in the present analysis, created in Tao et al. (2019)”. The referee thinks that it is not suitable to include the contribution of the database production for training the SegCloud (P3, L15-16).

Tao et al.(2019) have discussed the relation between the U-Net results and the human observers’ ones in detail. The similar discussion is found in the section 4.3 basically by

using the similar data frame (This paper used the data only of July, 2018, and Tao et al. used the data of August to November, 2018. The data site is the same.) If both analysis systems are different, it is useful and effective to discuss the difference between both results, but if not, this section may not be required in the paper because the detailed discussion has been already performed by using much more data.

I have asked my colleague with some comments of this paper, because he is an expert of this field. His comments are as follows,

The authors described a novel method for images segmentation based on CNN. They showed that the algorithm works well (i.e., good accuracy) if compared with the ground truth i.e., the images segmented by visual inspection. The CNN method provides improved results with respect to the traditional methods based on bands threshold. Further, they also give evidence of a good correlation with respect to cloud fraction computed by visual observation. Finally, the authors made public their WSISEG database. This is expected to be useful to the scientific community.

Major issues It is worth to mention that a paper describing the algorithm as well as some validation results have been recently published (Tao et al., 2019). I see that (a few) further details have been included in the present manuscript, but I don't believe that, at this stage, they can warrant a new publication. While the accuracy computed with respect to the ground truth is important and correctly reported, I would like to see more work regarding the comparison with other algorithms. The fixed threshold algorithm cannot be directly compared with the CNN output simply because it has been built to be used with a camera with a shadow band. Then, the actual fixed threshold algorithm (Long et al., 2006) is much more complicated than a simple R/B threshold shown in Fig. 4, and accounts (at least partially) for most of the issues mentioned in the current manuscript (e.g., solar obstruction). Your current comparison is clearly biased under clear sky and somewhat biased under partial cloud conditions. Then, the comparison performed under overcast sky makes sense, and indeed some studies used the R/B threshold method specifically to detect overcast sky occurrences (e.g., Dami-

ani et al., 2019). Therefore, I suggest comparing your results with additional/different more focused methods (e.g.,). Since Tao et al. (2019) already showed validations results with respect to visual observations for August-November 2018, please remove this part from the manuscript. I suggest including some applications exploiting the R/B method and its potentialities. For example, comparison with cloud fraction (or cloud mask) estimated by satellites (e.g., Himawari-8, MODIS. . .), analysis of trend/changes at different locations, adapting the same algorithm to images recorded by other cameras (since the method is based on CNN, it should be no so difficult).

Others The reference of the second segmentation method is Otsu (2007). However, I think that the authors actually refer to Otsu (1979) see https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4310076 Figure 2 -> The name of the two previous datasets showed in Fig. 2 are not mentioned in the text of the manuscript. In section 2, please include their names when their respective references are mentioned Figure 4 -> you should refer to the fixed R/B threshold algorithm with its appropriate reference (i.e. Long et al., 2006) in both Fig. 4 and main text Figure 4 -> please include also the original reference segmentation from the database

References mentioned above Long, C. N., Sabburg, J. M., CalboÌĄ, J., and PageÌĂs, D.: Retrieving cloud characteristics from ground-based daytime color all-sky images, Journal of Atmospheric and Oceanic Technology, 23(5), 633-652, 2006. Otsu, N.: A threshold selection method from gray-level histograms, IEEE Transactions on Systems, Man, and Cybernetics, 9(1), 62-66, 1979 Tao Fa, Wanyi Xie, Yiren Wang, and Yingwei Xia.: Development of an all-sky imaging system for cloud cover assessment, Applied Optics, 58, 5516-5524, 2019

Additional reference Damiani A., Hitoshi Irie, Tamio Takamura, Rei Kudo, Pradeep Khatri, Hironobu Iwabuchi, Ryosuke Masuda, Takashi Nagao, An intensive campaign-based intercomparison of cloud optical depth from ground and satellite instruments under overcast conditions, Scientific Online Letters on the Atmosphere, 15, 190-193,

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