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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Global analysis of cloud field coverage and radiative properties, using morphological methods and MODIS observations" *by* R. Z. Bar-Or et al.

Anonymous Referee #2

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General comments

The authors describe a morphological method to extract the shape and boundary of cloud fields, where cloud fields mean *detected* clouds and the related *twilight zone*, as opposed to the *real* cloud-free area. This algorithm is applied to one day of MODIS-Terra data and the results are discussed. Furthermore, the authors investigate aerosol properties (optical thickness and fine mode fraction) as a function of the distance from the nearest cloud for this same day.
The paper addresses interesting issues related to aerosol-cloud interactions and should be published in ACP after some revisions.

Specific comments

Major revisions are concerned with the following topics:

1. The authors address the same topic as in Bar-Or et al. (2010) in a very similar way. It should clearly stated what the differences and similarities between the two papers are and what the additional contribution provided by this manuscript is.

2. **Page 19569, lines 27–29 and also later in the paper**: The authors assert that a classification of cloudy and cloud-free areas should be resolution-independent. While it is clear that a real cloud has a definite extension that dooes not depend on reolution, it is also expected that different instruments with different spatial resolutions will give different representations of the same cloud field. Thus, a cloud field definition will be resolution-dependent yet. Please clarify what you mean by this sentence.

3. **Page 19571, line 10**: What do you mean by *detectable* clouds? Do you mean clouds that have been detected by a standard algorithm like the MODIS one (Ackerman et al., 1998)?

4. **Page 19571, line 21**: What do you mean by "any informative input data resolution"?

5. **Page 19571, lines 18–22**: I think that a robust cloud field masking algorithm that distiguishes between cloudy and cloud-free areas in the sense described in the paper should also satisfy the requirement that it does not (strongly) depend on the input cloud mask. Although usual cloud masking algorithms can be more or less conservative depending on their target and the intended application, the resulting separation between "cloud affected" areas and really cloud-free regions should eventually be the same. Does your algorithm satisfy this requirement? Please comment on this point.

6. **Page 19572, line 28 – page 19573, line 20**: These theoretical introductive paragraphs could be understood more easily by means of a practical example that is referred to in the course of the explanations. The references to Figs. 1 and 2 at the end are not enough. Furthermore, it would be nice to consider all the steps starting from an image of the cloud field which is missing in Fig. 1.

7. **Page 19587**: As far as Fig. 1 is concerned, why does the scale of panel b not start at zero? The distance-to-nearest-cloud should be zero when one is considering a cloud pixel. Can you please also explain why Fig. 1d is not a zoom of Fig. 1c but a different plot? What does it represent? The contour defined by R_0 could be added as well to both the cloud field representation (not plotted yet) and the cloud field distance map (Fig. 1a).

8. **Page 19588**: Please add the terms $A(r)$ and dA/dr to the caption of Fig. 2 in the appropriate way. The red curve seems very smooth while its derivative, the blue curve, is very noisy. Why is it like this?

9. **Page 19573, lines 13–17**: The meaning of the distance parameter R_0 should be better clarifed. It represents a characteristic length of the cloud field but it is not clear why it marks the cloud field boundary. Furthermore, it is a purely geometric quantity that in the first instance is not associated to any physical cloud or atmospheric property. Of course, clouds only form where the necessary meteorological conditions are satisfied... Please explain.

10. **Page 19573, line 25**: Please add some detail about data projection. Do you use the 1 km MODIS cloud mask or the 250 m cloud mask? Which method do you use? Nearest neighbour? Do you consider subpixel cloudiness in the resulting cloud mask? Do you correct for parallax effects?

11. **Page 19574, line 5**: Do you compute the distance in km or pixels? Is the distance a floating point? Do you consider distances from the center of a pixel to the center

of the closest cloud pixel? Is there a fast way to do these computations? Can you please give at some point in the paper an indication about time consumption of the algorithm? Does the physical extension of the data set (i.e. the size of the MODIS granule) play a role for the determination of the distance map?

12. **Page 19574, line 8**: Can you please better explain the meaning of $A(r)$ and its derivative and their relationship to each other? Do you first compute the distance probability distribution, as suggested by the fact that in step 2 you determine the distance map, or the distance cumulative distribution, as indicated in step 3?

13. **Page 19574, line 13**: How large is the Gaussian filter used? Can you please discuss here whether a minimum value R_0 can always be found (see also page 19575, after line 23)? How do you proceed in case no minimum could be found?

14. **Page 19575, line 13**: How do you determine the cloud mask at lower resolutions from the average of the high resolution mask? Which threshold do you use to say that a low resolution pixel is cloudy? How do you verify that cloud fraction is constant?

15. **Sections 3.2 and 3.3**: In the aerosol discussion all possible effects for the aerosol-cloud interaction in the twilight zone are mentioned (page 19578, lines 25–29), including also 3D radiative transfer enhancement effects. However, I have the impression that in the evaluation of the results the 3D effects are neglected, although Wen et al. (2007, 2008) have shown that they can play a very important role. In particular, these 3D effects can produce inaccuracies in the retrieved aerosol properties that are not related to any physical characteristics of the aerosol in the twilight zone. Hence, I do not think that the assertion on page 19579, lines 22–23 ("because of the significant difference in aerosol properties and its measured optical characteristics near detectable clouds") is correct. In fact, these observed differences could be artifacts caused by the 1D nature of

aerosol retrievals (i.e. by the neglect of 3D radiative transfer effects) or by undetected clouds that are misinterpreted as aerosol particles (as mentioned at the end of Sect. 3.3 but not in Sect. 3.2). Please comment on this and, in case, modify your conclusions.

Minor revisions:

1. **Page 19570, line 12**: Most algorithms do not only work with solar channels but also with thermal information. Moreover, these algorithms can work in different ways and produce different cloud masks depending on the application they are thought to serve. Please modify the text accordingly and comment whether this fact affects your algorithm.
2. **Page 19572, line 8**: Which algorithms do you mean by "Other methods"? Please cite the intended references.
3. **Page 19572, lines 11–14**: Please explain this concept a little more clearly.
4. **Page 19572, line 20**: "Euclidean distance transform" is a term that appears here for the first time without explanation, although the meaning has been illustrated above. Please add some clarification.
5. **Page 19577, line 3**: Is it 29 ± 1 km or 29 ± 9 km?
6. **Page 19577, lines 20–24**: How do you infer the CFF values for the various R_0 of 20 and 30 km?
7. **Page 19580, line 4**: Please give a reference for the assertion that the FMF product over land is affected by larger inaccuracies.

Technical corrections

Please check for the consistent usage of "cloud-free" or "cloud free" throughout the paper.

Page 19568, line 21: I think that "oceans" should not be written in capital letters.

Page 19571, line 13: as one approaches detectable clouds...

Page 19571, line 18: should comply with the...

Page 19572, line 2: one proposed a method using...

Page 19572, line 7: in the cloud field area.

References

Ackerman, S., Moeller, C., Strabala, K., Gerber, H., Gumley, L., Menzel, W., and Tsay, S.-C.: Retrieval of effective microphysical properties of clouds: A wave cloud case study, Geophysical Research Letters, 25, 1121–1124, 1998.

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Wen, G., Marshak, A., Cahalan, R. F., Remer, L. A., and Kleidman, R. G.: 3-D aerosol-cloud radiative interaction observed in collocated MODIS and ASTER images of cumulus cloud fields, Journal of Geophysical Research, 112, doi:doi:10.1029/2006JD008267, 2007.

Wen, G., Marshak, A., and Cahalan, R. F.: Importance of molecular Rayleigh scattering in the enhancement of clear sky reflectance in the vicinity of boundary layer cumulus clouds, Journal of Geophysical Research, 113, doi:doi:10.1029/2008JD010592, 2008.

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