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Atmospheric Measurement Techniques Discussions

Interactive comment on "Analysis of co-located MODIS and CALIPSO observations near clouds" *by* T. Várnai and A. Marshak

Anonymous Referee #2

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General comments

This paper combines data from the passive MODIS imager, and the active CALIOP lidar, in order to better understand the observed radiative behaviour near clouds, for low clouds (lower than 3 km). First, the authors carefully co-located MODIS and CALIPSO data, using CALIPSO WFC (wide field camera) and considering possible cloud drifting due to the orbit time gap between the two instruments. Then, they compared the MODIS and CALIPSO WFC's reflectance at the wavelength of 650 nm, showing nice agreement and explaining the slight differences in a convincing way.

The heart of this work includes analysis of two optical features as a function of

the distance from low clouds: CALIOP backscatter at 532 nm, and CALIOP color ratio (backscatter ratio between 1064 nm and 532 nm). The presented results show a sharp decrease of the lidar 532 nm backscatter as a function of the distance from cloud. The decrease slope and behaviour of the lidar backscatter when increasing the distance from clouds is found to be dependent on the source of the used cloud mask (the examined cloud masks are MODIS 2D mask, MODIS 1D mask based on CALIPSO's orbit, and CALIPSO's 1D mask). The differences found due to the selected cloud masks are properly discussed and presented.

Furthermore, the authors present similar behaviours in the lidar color ratio, and suggest a statistical correction scheme that enables the prediction of the color ratio as a function of the 2D distance from the nearest cloud, based on the 1D distance from the nearest cloud. This scheme may be very useful for future research, when a large dataset is available.

Finally, the authors present a global analysis of cloud fraction and median distance from clouds (of low clouds) above oceans, based on MODIS cloud mask. They show a significant seasonal variability of these parameters and explain some of it with the spatial typical distribution of the analyzed cloud fields.

This paper presents new techniques that can be used for future research, based on existing space-borne instruments. This paper also presents, for the first time, global spatial analysis of low cloud fields. This work's research objective is in the most important area of interest for the research of the transition zone between clouds and cloud-free atmosphere, which is essential for measuring and understanding the total radiative effect of cloud fields.

Therefore, I recommend this paper to be published in Atmospheric Measurement Techniques, with reservation to the authors' response to my comments below, in

hope that my comments could help the authors to improve their paper.

Specific comments

1. P. 6862 lines 2-21: Authors should define all abbreviations in abstract (MODIS, CLIOP, CALIPSO), and not only in P. 6864 lines 4-7.
2. P. 6862 line 21: The value of the mean distance to the clouds, as masked, is valuable. However, the authors should be careful when they use the terminology of "clear sky areas", while later in the manuscript they mention the possibility that these areas may contain "hard-to-detect cloudy cases" (P. 6867 lines 15-20).
3. P. 6863 lines 2-8: Here, the authors present several factors that may affect aerosol size distribution near clouds. I think that the readers would better understand each factor if they had references for the proposed mechanisms affecting aerosol size near clouds.
4. P. 6865 lines 3-9: It is mentioned that a time gap of 72 seconds may result a difference in the images of MODIS and CLIPSO due to cloud movement by winds, and a very nice correction algorithm is presented for fixing this problem. I wonder if 72 second gap may also influence the difference between the images because of cloud formation or evaporation processes, in particular in small cloud fragments which are probably very common in the transition zone (Koren et al., 2008). Perhaps the authors can add this point to the discussion.
5. P. 6865 line 21: If this work concentrates in cloud whose top is up to 3 km, as I understand from the caption of Fig. 3, the authors should state it clearly in this line.

6. P. 6868 line 2: Koren et al., 2007 found the mentioned scales using twenty MODIS granules. The authors are suggested to add to this reference Bar-Or et al., 2011, who found similar scales using global MODIS dataset, with separation between cloud field types..
7. P. 6870 lines 1-2: The present correction for 1D data presented here is very impressive, but the authors, who stated that it's "statistically account for clouds lying off the CALIOP track", should stress out it may be done only for large statistical set, for a yearlong period, and that the correction may be dependent on the cloud field type (or maybe elevation).
8. P. 6870 lines 21-25: The authors are requested to define "summer" and "winter" by specifying dates.
9. Table 1: The authors are requested to define "summer" and "winter" by specifying dates.
10. Fig. 5: If this analysis was done on the same dataset that was used for Fig. 4, please mention it. Otherwise, please mention the data time range.
11. Fig. 6(a) and Fig. 6(b): The authors are asked to expend the description of the data used for the analysis presented in these figures? For example, did you calculated the cloud fraction from the 1 km MODIS cloud mask product, or used the cloud fraction product provided by MODIS for coarser resolution? It seems that the resolution of Fig 6 is around 1 degree. Can it be finer using MODIS high resolution products?
12. Fig 6(a): The authors are asked to describe in the caption whether they have used MODIS or CLIPSO cloud mask for this panel.
13. Fig 6(a): If MODIS data were used for this figure, it seems to me that the high distance from cloud values close to the poles may be a result of cloud mask

data artefacts, caused by ice covered surface. I would suggest the authors to recheck the data quality in these areas and exclude the biased data points from this analysis.

Technical corrections

1. P. 6865 line 18: please replace ")." with".)".
2. P. 6865 line 27: please replace ")." with".)".
3. P. 6868 line 21: please replace ")." with".)".
4. Fig. 2: please keep consistency on the axes labels (e.g. mention that MODIS reflectance is R_{MOD} in all axes etc.).
5. Fig. 4(a) and Fig. 4(b): please keep the same axes scale, so that the slope differences would be clearer. Also, please use the same line width for the linear fits in all panels.
6. Fig. 4(c): please add date and time of the presented MODIS image.
7. Please keep consistency in the manuscript when describing area segment sizes ("XX km by YY km" or "XX km x YY km").
8. Please keep consistency in the manuscript and choose either "distance from clouds" or "distance to clouds".

References

Koren, I., Oreopoulos, L., Feingold, G., Remer, L. A., and Altaratz, O.: How small is a small cloud?, *Atmos. Chem. Phys.*, **8**, 3855-3864, 2008.

Interactive comment on Atmos. Meas. Tech. Discuss., 4, 6861, 2011.