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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A better understanding of cloud optical thickness derived from the passive sensors MODIS/AQUA and POLDER/PARASOL in the A-train constellation" *by* S. Zeng et al.

Anonymous Referee #1

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General comments

The authors present a comparison between cloud optical thickness derived from AQUA/MODIS and PARASOL/POLDER. Reasons for differences are investigated.

The paper explains why cloud optical thickness from these two sensors can differ and gives hints about how to compare cloud climatologies from different instruments and/or about how to create sound cloud climatologies. It should be published in ACP. Nevertheless, some some more explanations should be added and aspects of the result

presentation should be first improved.

Specific comments

As a general remark, the authors should explain clearly in the introduction the innovative aspects of their study, in particular in view of the already exisiting cloud climatologies and of the references that already deal with similar topics, (e.g. Zhang et al., 2009; Zeng et al., 2011). Furthermore, figure axes and color scales should be explained in detail.

The main issues to be improved are:

P. 11737, l. 25: Are there further differences in the microphysical and optical description of liquid clouds between POLDER and MODIS apart from the fact that POLDER must use fixed effective radii? This is an important information for Sect. 4.2.

P. 11738, l. 6: POLDER uses a single and fixed Inhomoheneous Hexagonal Model (C.-Labonnote et al., 2000; Labonnote et al., 2001): please explain what you mean by *single and fixed*, in particular whether a particle size distribution is considered in this approach.

P. 11738, l. 19–22: The averaging procedure for POLDER COT is a weighted averaging according to p. 11748, l. 5–7. This should already be mentioned here.

P. 11738, l. 26–29: Main differences between POLDER and MODIS should also include the different veiwing geometries of the two instruments.

P. 11739, l. 5–8: Please give a more detailed explanation of the PM dataset. Even if it can be found in Zeng et al. (2011), it would make it easier for the reader to have it here as well. A part of this description is already given in the present paper anyway. That PM means POLDER-MODIS is obvious, nevertheless it could be mentioned explicitly. In contrast to Zeng et al. (2011), it should be mentioned that only $20 \times 20\,\mathrm{km}^2$ pixels

that are classified as cloudy or partially cloudy by both instruments at the same time are considered for this study.

P. 11739, l. 12: With respect to cloud fraction, please explain where this information comes from. For POLDER: is this oly the result of the aggregation to the $20\times20\,\mathrm{km}^2$ pixels? For MODIS: is the $250\times250\,\mathrm{m}^2$ considered here?

P. 11739, l. 15–16 and **Fig. 1:** It is not clear from Fig. 1 that POLDER COT is generally larger than MODIS COT. Please use the same scale from 0 to 30 in all plots in Fig. 1 and add also some value in the scale between 0 and 30. This sentence is in part contradicted by the next Figures where MODIS shows larger COT than POLDER. Please explain.

P. 11739, l. 21–22: You say that most of the convective clouds are composed of ice. Please specify this sentence: it is actually the part of the convective clouds that can be seen with passive space-borne instruments that is mainly composed of ice. In the lower part of the clouds liquid water is present though.

P. 11740, l. 26: You introduce the scaled optical thickness here as well as the asymmetry parameter g (g is not explained here at all). A detailed explanation of the scaled optical thickness is given on p. 11745, l. 22–27. Please move that explanation to this point of the manuscript including eq. 1, which should be inserted directly after *where* g *is the asymmetry coefficient* (p. 11745, l. 24).

P. 11741, l. 10–12: Why does POLDER COT increase polewards? Please explain.

P. 11741, l. 19–20: Why is there almost no latitudinal variation in POLDER COT? Please explain.

P. 11742, l. 8–11: Why is there a peak in Spring in Fig. 3a? Please explain.

P. 11742, l. 21 and **Fig. 4, 5, 7:** Pixel-to pixel comparisons are performed by means

of two dimensional histograms. Please explain this fact and explain the color scale as well.

P. 11743, l. 17: Different spatial resolutions can explain part of the differences between the cloud fractions of the two sensors. Which additional reasons could also explain these differences?

P. 11745, l. 22: What about differences in microphysical models for water clouds?

P. 11746, l. 1: Please explain what you have plotted in Fig. 7 (overcast ocean...).

P. 11747, l. 2: Here and in Sect. 4.3 you talk about rainbow directions, but you probably mean cloudbow directions. Rainbows are produced by precipitation (i.e. rain drops) while cloudbows stem from the much smaller liquid water droplets that make up the cloud. Please correct/comment on this.

P. 11747, l. 5–19: Please discuss the effect of a fixed ice cloud effective radius used by POLDER for the comparison with MODIS. Youe also mention in the Conclusions (**11750, l. 19**) that cloud particle sizes conduct to the main differences between POLDER and MODIS. I think this issue is not clear enough and deserves a more profound explanation.

P. 11748, l. 7–9: Please explain that polar graphs in Fig. 8 represent the azimuth angle (0–360°) and the viewing zenith angle (0–??).

P. 11748, l. 16: It is not really clear that COTs increase with solar zenith angle since large COT ranges and variabilities are shown. Do you base your assertion on mean COT values? Please quantify this sentence.

P. 11748, l. 18–19: The 3D effects mentioned here are 3D radiative effects that should be sketched explicitly in addition to the references.

P. 11748, l. 22–23: Is the COT in forward directions 75% or 50% of the angular mean?

What do you mean with forward directions? Is it only the forward direction ϕ=180° or a range of ϕ around 180°? Please explain.

P. 11748, l. 25: Please illustrate the role of cloud heterogeneity in this context.

P. 11749, l. 11: The rainbow/cloudbow directions should be indicated explicitly using azimuth and zenith angles in order to identify them clearly in the figures.

P. 11750, l. 25–26: Please make this sentence *However,...* more explicit.

Figures: Please use one abbreviation for all figures: either liq(P)/liq(M)/ice(P)/ice(M) or liq(P.)/liq(M.)/ice(P.)/ice(M.) or POL-Liq/MOD-Liq/POL-Ice/MOD-Ice.

Figures: Please use one abbreviation for all figures: COT^P/COT^M or COT(POL.)/COT(MOD.).

Figures: Please keep a fixed order for your comparisons Liq-Liq or Ice-Liq. In Fig. 1 Ice(P)-Ice(M) comes in the third row, while it usually occupies the last position in the other figures.

Figures: Please make sure that figures are large enough to be readable in the print version of the article. Fig. 5 is fine for instance while Fig. 4 is too small.

Fig. 1: It is necessary to use the same color scale for POLDER and MODIS COT in all graphs, otherwise it is not possible to make a clear comparison. The color scale should also contain some intermediate number and not only the lower and upper limits (e.g., 0 and 20 in the fiirst column). In the caption: *Geographical distributions of ... –> Geographical distributions of mean ....*

Fig. 2: Please explain COT^P and COT^M. In the caption: *right axis –> right axis, blue* and *left axis –> left axis, red*.

Fig. 3: Please add the information about the hemisphere in the latitude ranges, e.g.,

30° – 60° –> 30° – 60° S. The y-axis range should be extended (to 10?) because data in panels (c) and (d) cannot be distinguished from the legend. Please add also the COT=zero line to all graphs. In the caption: *figures correspond annual mean –> figures correspond to annual mean*.

Fig. 4: Please explain that these are 2D-histograms and the color scale! Please add *Ocean* to the plot title and to the caption.

Fig. 6: Are the titles of the two plots correct? Do you really investigate only liquid clouds over ocean? Do you use the same cloud sample in (a) as well as in (b)? If yes, *Only the liquid clouds over ocean are considered* sounds strange in the caption. What does *Overcast* refers to? Do you only consider POLDER pixels that have CF=1 according to POLDER itself while the MODIS CF can be different from 1? Please explain this in the caption and in the text. The left y-title of plot (b) and the right y-title of plot (a) overlap. Please separate them.

Fig. 4+6: Please explain that these are 2D-histograms and the color scale!

Fig. 8+9: Please explain that these are 2D-histograms and the color scale! Please add the total number of observation per sza sample. Please add *liquid* to the caption. Please explain both axes and ranges of the polar graphs.

Technical corrections

Please explain IR and NIR, even if almost trivial.

P. 11734, l. 9: *are also discussed –> are discussed*.

P. 11736, l. 5: Please explain AVHRR here and not on l. 12.

P. 11736, l. 12: *Many satellites –> Many satellite sensors*.

P. 11736, l. 12–13: The references indicated here to the AVHRR, SEVIRI, MODIS and POLDER retrievals are only examples since many groups worldwide have developed retrievals for these sensors. Please add *e.g.,* to the references.

P. 11736, l. 20: *and analyze their main –> and analyzed their main*.

P. 11738, l. 29: *and provide particle size –> and provides particle size*.

P. 11740, l. 3: *can also extent –> can also extend*.

P. 11740, l. 11: *at the cloud top –> about cloud top*.

P. 11741, l. 13: *Figure 2e–h presents –> Figures 2e–h present*.

P. 11744, l. 17: *to larger the dispersion –> to larger dispersion*.

P. 11746, l. 14: *remove dependence –> removes dependence*.

P. 11748, l. 24: *This comes, –> This comes*.

P. 11750, l. 2: *retrieves logically larger COT –> retrieves larger COT*.

P. 11750, l. 2: *we concluded not surprisingly that –> we concluded that*.

P. 11751, l. 1: *climatolotical –> climatological*.

References

C.-Labonnote, L., Brogniez, G., Doutriaux-Boucher, M., Buriez, J.-C., Gayet, J.-F., and Chepfer, H.: Modeling of light scattering in cirrus clouds with inhomogeneous hexagonal monocrystals. Comparison with in-situ and ADEOS-POLDER measurements, Geophysical Research Letters, 27, 113–116, 2000.

Labonnote, L., Brogniez, G., Buriez, J.-C., Doutriaux-Boucher, M., Gayet, J.-F., and Macke, A.: Polarized light scattering by inhomogeneous hexagonal monocrystals: Validation with ADEOS-POLDER measurements, J. Geophys. Res., 106, 12 139–12 155, 2001.

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Zhang, Z., Yang, P., Kattawar, G., Riedi, J., Labonnote, L. C., Baum, B. A., Platnick, S., and Huang, H.-L.: Influence of ice particle model on satellite ice cloud retrieval: lessons learned from MODIS and POLDER cloud product comparison, Atmos. Chem. Phys., 9, 7115–7129, doi:10.5194/acp-9-7115-2009, 2009.

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