Review of "An assessment of cloud top thermodynamic phase products obtained from A-Train passive and active sensors" by S. Zeng, J. Riedi, F. Parol, C. Cornet, and F. Thieuleux

1 General Comments

This paper demonstrates a global comparison of multiple years of colocated cloud thermodynamic phase retrievals from MODIS and POLDER. The phase retrievals are also compared with CALIOP depolarization ratio and backscatter as well as CALIOP thermodynamic phase and cloud top temperature retrievals. The authors are correct that cloud thermodynamic phase retrievals are important, especially for further cloud microphysical property retrievals, but the purpose of the comparisons presented in the paper were not well motivated. The paper itself is rambling rather than organized and not enough information about the data products, colocations procedures, or analysis techniques was presented to meet the reproducibility standards of a good scientific paper.

The main issue that I have with this paper is that it does not seem entirely necessary. Riedi et al. (2010) already convinced me that a combined MODIS and POLDER phase retrieval could address demonstrated issues inherent in each phase retrieval on its own. While other papers have statistically evaluated the MODIS IR and SWIR phase products with respect to CALIOP (Cho et al. 2009, 2008, respectively), this does not seem to be the case for the POLDER phase product, so there is definitely value in the comparisons (Fig. 9 is particularly effective). But, I strongly feel that this paper would be much stronger if it focused on comparing a combined phase algorithm such as the one proposed in Riedi et al. (2010, Fig. 4) implemented globally, with respect to MODIS, POLDER, and CALIOP.

I feel that significant revisions are necessary for the paper to be published in *Atmospheric Measurement Techniques*.

2 Specific Comments

S1. Comparisons with the combined phase algorithm proposed in Riedi et al. (2010) should have been included. (I do not feel that this is an undue request considering the author overlap between this paper and Riedi et al. (2010).)

S2. The Introduction section does not make a strong case for the purpose of the conducted study.

S3. The abstract is written in the style of a conference submission abstract rather a scientific paper abstract. It should be revised to quantitatively summarize the most relevant results.

S4. P8375, L24 The paper states that "the offcial cloud phase products from MODIS use index values representation (1 for ice, 2 for liquid, 3 for mixed)". Please explain what is meant by MODIS mixed-phase in this study. The Collection-5 MODIS VIS/SWIR retrieval (Cloud_Phase_Optical_Properties) does not have a mixed-phase category and the Collection-5 MODIS IR retrieval no longer uses the mixed-phase category (as of Collection-5). This, in turn, leads to questions about the pixels included in the MODIS mixed categories in Figures 1 and 2, e.g. It's reassuring to see that only very small percentages of pixels fall in to the MODIS "mixed" categories, but it is disconcerting that these pixels were included in the data set with no discussion of what they mean. My only assumption is that they are associated with the colocation process, but I have no way of knowing because so few details were presented. It is also strange that they occur so much more frequently over snow.

S5. It is not always clear which MODIS phase product is being used in various parts of the study. P8377, L17 states "If not otherwise specified, cloud phase used for the comparison with POLDER is the latter one as it corresponds to the daytime algorithm and benefits from the combination of both solar and thermal infrared measurements." The cases where the MODIS IR algorithm are used should be made explicitly clear and, if possible, the results from the SWIR algorithm should also be included.

S6. The Conclusions section discusses the effects of combining MODIS and POLDER, yet such a combination was not done in this paper. (A comparison is not the same as a combination and the conclusions section should focus more on the results and their implications.)

S7. Technical editing for English language readability is necessary and goes beyond what I am willing to do as a reviewer. Therefore I have not included typos and other issues in the Technical Comments that follow.

3 Technical Comments

The following comments can be viewed as minor issues.

C1. P8373, L25 states "The combination of different methods to improve discrimination capabilities is increasingly used for cloud phase retrieval from satellite observations." Yet several of the methods listed do not combine retrieval methods. Please revise.

C2. P8374, L23 states "Past studies of cloud phase from sensors of the A-Train (e.g. POLDER, MODIS, CALIOP or AIRS) have mainly focused on individual case analysis or radiative transfer simulation (Riedi et al., 2010; Chylek et al., 2006; Cho et al., 2009; Kahn et al., 2011) and had not concerned the global long-term assessment of cloud phase using both passive and active sensors in this A-Train constellation." I feel that this is somewhat of a mischaracterization of Riedi et al., 2010; Cho et al., 2009; and Kahn et al., 2011. I recommend revising the quoted statement to better represent the actual findings of the cited papers and then provide more appropriate motivation for the conducted study.

C3. P8375, L15 Please explicitly state the time periods included in the study. Regarding the POLDER/MODIS dataset, the text only says that *all* Aqua/MODIS collection 5 level 2 cloud products and PARASOL/POLDER collection 2 level 2 cloud products are colocated.

C4. P8376, L1 "In other situations where both liquid and ice are present within a POLDER superpixel, either liquid or ice dominated phase, or mixed phase is labeled depending on the number of liquid and ice pixels." Please provide details explaining when the superpixel will be assigned each case.

C5. P8375, L16 Please provide more details regarding the colocation of the MODIS and POLDER products. In addition, please define what is meant by a *pixel* in the context of this work.

C6. P8378, Section 2.3 Please specify exactly which CALIOP product is used in the analysis.

C7. P8382, Section 3.1 The comparison focuses on cloudy, overcast, broken, and multilayered scenes, yet *overcast* and *broken* are never explicitly defined in the context of the study. The use of the MODIS overlapping cloud flag is also problematic because the colocation process is not described in enough detail and it is not clear how a common pixel is defined.

C8. P8387, L4 states "In cases where POLDER and MODIS have inconsistent decisions, CALIOP tends to agree with POLDER more often." I do not feel that Fig. 3 supports this assertion *except* for the POL (liq)-MODIS (ice) case.

C9. P8387, L14 states "provides a global qualitative understanding of each of the 9 classes obtained when merging POLDER and MODIS products." Since the POLDER and MODIS products have not been merged, this statement does not mean anything. (Colocating two products is not the same as merging products.)

C10. P8394, Section 5.3 and Fig. 10 Inclusion of "Using IR brightness temperature or brightness temperature dfferences provides little information to discriminate cloud phase due to the small contrast between supercooled and ice water." implies that Fig. 10 shows the MODIS IR phase results. If this is the case, please state it explicitly *and* include the MODIS SWIR phase results in the figure and discussion. If it is not the case, please remove the quoted sentence.

C11. P8394, Section 5.3 and Fig. 10. It should be mentioned in the text that the CALIOP phase algorithm does make use of cloud temperature in its phase determination (Hu et al. 2009).

C12. Section 5.4 I do not feel that the section discussing aerosols is quantitative enough to be included in this paper. In addition, the statement in the Conclusion on P8397, L13 "From this study we have seen that POLDER can erroneously detect broken clouds scenes and aerosols overlaying water clouds as mixed or ice phase" is not justified by the study. There is a CALIOP aerosol product that could form the basis for a more detailed study.

C13. Section 5.6 Is a snow mask used in this study? If so, it should be stated.

C14. Figure 1 The numbers and some of the light colored fonts in the text to the left of the pie charts is difficult to read on a screen without significant magnification. Perhaps this would not be difficult in a print-out, but so many people read papers on computer screens and tablet devices that this is an issue.

C15. Figure 3's caption states that it shows opaque clouds, as does Figure 4's caption. Yet only Figure 4 has the text "Opaque Clouds" above the figures.

C16. Figures 5-7: The information in these figures could be more easily conveyed in tables.

References

Cho, H.-M., S. L. Nasiri, and P. Yang, 2009: Application of CALIOP measurements to the evaluation of cloud phase derived from MODIS infrared channels. *J. Appl. Meteor. Climatol.*, **48**, 2169–2180.

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Hu, Y., et al., 2009: CALIPSO/CALIOP cloud phase discrimination algorithm. *J. Atmos. Oceanic Technol.*, **26**, 2293–2309, doi: 10.1175/2009JTECHA1280.1.

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