Anonymous Referee #3

This paper provides a comparison of two techniques for identifying cases of aerosol above clouds. The comparison is of an active lidar-based technique using data from the space-borne CALIOP instrument, and the other is a passive imager-based technique combining data from the MODIS and OMI instruments, which are available during daytime only. The two techniques rely on measurements with very different characteristics, and therefore one should expect significant differences between the two, yet both techniques have been used previously in the literature to draw conclusions about the frequency and consequences of aerosol over cloud. Thus a comparison of the two the other two reviewers that this paper does not quite succeed in clearly articulating why the two techniques agree or disagree for different regions or conditions. Nor is it clear what we have gleaned that is new about conditions of aerosol over cloud as a consequence of this comparison. The paper should be suitable for publication in ACP if the authors can revise the manuscript to better distinguish the differences between the techniques and how they contribute to the differences between them. This is elaborated a bit more below.

Response: We would like to thank the reviewer for his or her comments. Point is taken and we have added a new Section 4.2 to explore the difference of the two methods. In particular, collocated OMI-MODIS-CALIOP data are used to explore the difference in ACA frequencies from the two methods, and our study suggests that the difference in cloud detection capabilities and QA flags are among the major causes of the difference.

Section 4 provides an extensive discussion of the global patterns of aerosol over cloud from the two techniques. However, the discussion completely ignores one of the key distinctions (also noted by the other reviewers), that CALIOP detects the presence of scattering aerosol while OMI primarily responds to the presence of UV absorbing aerosol. The obvious question left unanswered here is: how much of the difference between the two techniques is attributable to this fundamental difference in the nature of the aerosol detection? Furthermore, can the CALIOP aerosol detection (or perhaps published aerosol climatologies) provide some guidance on where we should expect the techniques to agree and disagree?

This is a good question. We have performed an analysis separating UV-absorbing from non-UV absorbing aerosols using CALIOP's ability to distinguish different aerosol types. Our study suggests that UV-absorbing versus non-UV-absorbing aerosol is not the major cause of the difference between the two methods as the majority of the ACA events are UV-absorbing aerosol related (dust, smoke, polluted dust as indicated by CALIOP). The results are discussed within the text of the manuscript (Section 4.2).

Echoing another comment also made by another reviewer: the MODIS cloud detection is performed at a much larger spatial scale compared to CALIOP. For example, if the authors are screening the data according to MODIS cloud optical thickness, then they are restricted to cases where the cloud is homogeneous on spatial scales of 1 km. At best, MODIS can only identify clouds at scales of 250 m or larger. Thus the MODIS cloud mask may miss many cases of small *clouds. In contrast, the CALIOP level 2 data are based on individual LIDAR samples with a comparatively much smaller footprint. Can the authors determine that there are many cases where CALIOP identifies aerosol over small clouds that MODIS/OMI is likely to miss?*

Response: This is a good point to bring up. We have performed a pairwise comparison between OMI, MODIS and CALIOP data sets from June 2006 to November 2008 in order to investigate what percentage of ACA scenes is being missed by each method. As the reviewer suggested, the CALIOP-reported cloud frequencies are higher in general due to a better detectability of small and/or thin clouds (Section 4.2). That is one of the reasons why OMI_MODIS-based algorithm reports higher ACA frequencies over North Africa. We have included both figures and discussion in the paper.

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