Atmos. Chem. Phys. Discuss., 15, C746–C749, 2015
www.atmos-chem-phys-discuss.net/15/C746/2015/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Investigating the frequency and trends in global above-cloud aerosol characteristics with CALIOP and OMI" *by* R. Alfaro-Contreras et al.

Anonymous Referee #2

Received and published: 12 March 2015

Comment on "Investigating the frequency and trends in global above-cloud aerosol characteristics with CALIOP and OMI"

This paper studies the capabilities and limitations of two satellite-based ACA-detection methods, CALIPSO-lidar vs. OMI UV AI, through a series of inter-comparisons and sensitivity tests. My overall impression of this paper is that many problems exposed here, e.g., passive and active sensor difference for aerosol retrieval, CALIPSO daytime vs. night time difference, OMI instrument issue, have already been known or studied in the previous work. While it is interesting to see these issues manifest as problems in ACA-detection, this paper doesn't seem to shed new light on those problems. In

addition, there are quite a few confusing arguments and technique issues in the study that need to be clarified. Overall, I find it difficult to recommend publication of this paper unless it is revised and improved substantially. Below is a list of major concerns and questions that I think should be clarified.

General comments âĂć First of all, I didn't find the exact definition of above-cloud aerosol (ACA) in the paper. I understand that the definition is subjective and instrument-dependent. But there ought to be a clear definition in the paper (I'd suggest a separate and dedicated section) about what is ACA to CALIPSO and MODIS-OMI. For example, how is ACA defined and identified using CALIPSO data? The description in Section 2 is too vague. What is the CALIPSO horizontal averaging limit (5km, 20km or 80km) used in aerosol detection? And why? Is the CALIPSO result sensitive to horizontal averaging? For OMI-MODIS combination, is there requirement on sub-pixel cloud fraction, cloud optical thickness or cloud inhomogeneity? I'd like to see these questions addressed, along with tables or flowchart to show the definition and identification of ACA in the revised paper.

âĂć There is little discussion on the dramatic difference in footprint size and therefore sampling rate between CALIPSO and OMI. CALIPSO's L2 product has resolution up to 333m, while OMI has a much larger footprint of 13x24km. As such, many issues could come in the way when comparing the two. For example, is it possible that some portion of OMI footprint is covered by ACA while the rest is covered by clean cloud or even clear-sky? What does the CALIPSO tell about such scene? How to reconcile the difference between CALIPSO and OMI in such case? I suspect that the difference between the two methods over the dust region may be partly caused by this. Clouds in generally are more broken over the dust region than the sub-tropical stratocumulus region. It seems possible that in such case CALIPSO would yield less ACA-detection that OMI. A related question (already mentioned above) is what horizontal averaging limit is used to screen CALIPSO data. In the operational CALIPSO layer product, the CALIPSO lidar signal may be averaged over up to 80km scale to obtain better signal-

to-noise ratio. \Note that difference horizontal scales maybe used for aerosol and cloud layers in the CALIPSO product. What is the impact of this difference on the ACA detection using CALIPSO?

âĂć There is also little discussion on the cloud detection in the paper. CALIPSO ACA detection relies on CALIPSO cloud detection. OMI-MODIS ACA detection relies on MODIS cloud detection. It is known that CALIPSO and MODIS have different sensitivity to cloud and their cloud masking products are different. For example, sub-visible thin cirrus clouds are frequent in the tropics. As a result, it is possible that CALIPSO sees three layers, cirrus at the top, a dust layer in the middle and a low cloud layer at the bottom. Is this an ACA case for CALIPSO? Would OMI-MODIS report different in this case? The impact of cloud masking difference on the ACA frequency difference should be investigated and reported in the paper.

âĂć I'd suggest the authors not to use the word "trend" (instead use "multi-year variation" or "inter-annual variation") in this paper. Only 8 years of data are used here. I am not convinced such a short time period can tell us anything about trend. Moreover, CALIPSO has a very limited sampling rate. I found it difficult to believe CALIPSO is able to detect any trend within 8 years. In fact, my impression is that the last few sections are not really about trend, but more about an issue in OMI instrument. So why not directly say so in the manuscript? Detailed comments/questions? âĂć In section 3, the discussion on Figure 1 is confusing and hard to follow. Are you suggesting that ideally if a perfect lidar detects aerosols above every cloud, Figure 1a should be same as Figure 1b? I could agree with the statement that "there are always aerosols above clouds", but I don't really see why Figure 1 is necessary. After all, there is no "perfect instrument" that is able to detect ACA over every cloud and there is no need to do so either. So I'd suggest removing Figure 1.

âĂć There should be some information about the quality control metrics used to screen the data in Section 3.

âĂć The ACA frequency for OMI-MODIS combination is defined as "the number of collocated MODIS-OMI cloudy scenes with AI retrieval greater than our noise floor (e.g., 1.0) divided by the number of MODIS cloudy scenes with valid AI retrievals." Is there any MODIS cloudy scene with invalid AI retrievals? What is fraction of such case? Why not just use MODIS cloudy scenes as denominator?

âĂć Is there any requirement about MODIS cloud fraction (for example >90%) when identifying the OMI-MODIS ACA scene? Is the result sensitive to this?

âĂć I'd like to see some aerosol type analysis (using CALIPSO aerosol type product) when CALIPSO and OMI disagree on the ACA detection. Note that OMI AI is more sensitive to absorbing aerosols than scattering aerosols, while CALIPSO is mainly sensitive to backscatter. This sensitivity difference might explain the difference in ACA frequency in certain region e.g., SE Asia.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 4173, 2015.