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Atmospheric Measurement Techniques Discussions

Interactive comment on "A 12-Year Long Global Record of Optical Depth of Absorbing Aerosols above the Clouds Derived from OMI/OMACA Algorithm" *by* Hiren Jethva et al.

Z. Zhang (Referee)

zhibo.zhang@umbc.edu

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General Comments: This paper documents the above-cloud aerosol retrieval algorithm based on the OMI observations (OMIACA) and the corresponding 12-year climate data record of above-cloud aerosol optical depth from this algorithm. The paper starts with the description of the theoretical base, implementation and uncertainty analysis of the algorithm, followed by a climatology study of the geographical distribution of above-cloud aerosols, their occurrence frequencies and their AOD trend.

The OMACA product, along with several other products, provides the much-needed observations for studying the above-cloud aerosols and their interactions with clouds

and radiation. This paper provides the documentation of the algorithm that enabled the OMACA product and therefore is an important contribution to the literature.

This paper very well was written and organized. Its topic is suitable for AMT. I only have some minor comments/suggestions for the authors to consider to further improve the paper.

Specific comments:

Introduction: a couple of important papers in the field of above-cloud aerosol studies are missing in the introduction. They should be cited to give the readers a more comprehensive and complete overview of the field. o Devasthale and Thomas [2011] is among the first to study the occurrence of above-cloud aerosols.

o Zhang et al. [2016] further studied the occurrence frequencies of different types of above-cloud aerosols over the globe using 8 years of CALIOP observations. They also derived the shortwave direct radiative effects of above-cloud aerosols based on the collocated observations of CALIOP ACA AOD and MODIS COD.

o Min and Zhang [2014] showed that the direct radiative effects of ACA also depend on the diurnal cycle of cloud. This study should be cited when discussing the factors influencing the DRE of ACA (i.e., around line 14)

o A recent study by Lu et al. [2018] showed that the entrained ACA from cloud top can significantly influence the cloud microphysics and actually brightens the clouds in the SE Atlantic region. This paper can be cited with Wilcox 2012 on the importance of ACA.

I think a brief overview of the existing above-cloud aerosol retrievals algorithms for the passive sensors will give the readers a "big picture" and understand the relative position of this study. In particular, as the authors are aware, the following algorithms have been developed for POLDER and MODIS

o Waquet et al. [2013b] and Waquet et al. [2013a] described a novel algorithm for retrieving the ACA properties from the POLDER observations.

o Meyer et al. [2015] developed a method for retrieving the ACA-AOD and COD below simultaneously from MODIS observations.

o Sayer et al. [2016] extended the “deep blue” aerosol retrieval algorithm to the above-cloud conditions.

Aerosol type identification (section 2.2.2.1): This part is very important, Because the retrieval algorithm uses different optical properties for different type of aerosols, i.e., dust or smoke. A misclassification can cause retrieval errors and uncertainties. However, the description of this paper is very brief. Some more details need to be added with proper references. For example, it should be mentioned whether and how the identification scheme is validated or evaluated. Has it been compared with CALIOP aerosol subtypes? Why different threshold of CO is used for northern and southern hemispheres?

âĂć Single scattering albedo (section 2.2.2.1): the SSA is extremely important for ACA retrieval and DRE. I hope the information of aerosol type and the corresponding SSA will be part of the OMIACA so the users can use it in a consistent way with the AOD product.

âĂć Look-up-tables (section 2.2.24): How is cloud effective radius considered in the LUT? Is it assumed as a constant? Note that the assumption of CER could have impacts on the COD retrieval. Some discussion is needed to clarify this.

âĂć Partly cloudy pixels: the footprint size of OMI is 13x24 km (338km2). At this scale, there cloud be a lot of partly cloudy pixels. One of my main questions/concerns is about the treatment of the partly cloudy OMI pixels. It seems to me the OMIACA algorithm is applied to both overcast pixels and partly cloudy pixels, correct? How is the subpixel cloud fraction determined? How are the partly cloudy pixels treated in the LUT and radiative transfer simulations? How is the UVAI of clear-sky part of the partly cloudy

pixel different from that of the cloudy part, and what is the meaning of the “observed” UVAI for the partly cloudy pixel? I would strongly recommend the authors to add a separate and dedicated sub-section to discuss the treatment of partly cloudy pixels in the OMIACA algorithm.

âĂć Sub-pixel COD variation: A related question is whether and how the algorithm accounts for the subpixel COD variation. What is the physical meaning of the “retrieved COD”? Is it a simple mathematical mean or some kind of weighted mean?

âĂć Spatial distribution of ACA: As mentioned above Zhang et al. (2016) studied the global distribution of different types of ACA. Actually, Figure 5 agrees reasonably well with the Figure 2 of Zhang et al. (2016). In addition, Zhang et al. (2016) also found significant amount of ACA over the north pacific due to the Asian dust and pollution. This study should be cited here and discussed.

âĂć Figure 5 shows some ACA over the Southern Ocean in January and February. Is this true or some retrieval artifact?

âĂć It is interesting to see that the FOACA in Figure 5 and the ACA AOD in Figure 8 are highly correlated. Is this a coincidence or there may be some real connection between them? One could argue that the region with high FOACA does not necessarily have larger ACA AOD. Do you agree?

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