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Atmospheric Measurement Techniques Discussions

Interactive comment on "A Dark Target research aerosol algorithm for MODIS observations over eastern China: Increasing coverage while maintaining accuracy at high aerosol loading" *by* Yingxi R. Shi et al.

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Title: A Dark Target research aerosol algorithm for MODIS observations over eastern China: Increasing coverage while maintaining accuracy at high aerosol loading

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I have a few comments below that are specific to the cases that were identified as high AOD pollution days by the research algorithm but were not identified as AOD>1 by

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AERONET.

Abstract: “We also find that the research algorithm is able to identify additional pollution events that a triad of AERONET instruments surrounding Beijing could not.” First, related to the triad of AERONET sites please note somewhere in the text that the Beijing-CAMS site was missing data from February 9 through March 12 (over one month) due to an equipment issue.

Lines 460-465: “There were 17 days when the research product identified a polluted day but AERONET did not, and 7 days when AERONET observed AOD > 1.0 but the research algorithm did not capture the event. It is easy to understand when AERONET identified a polluted day but the research retrieval did not, because the AERONET observation time can be different from MODIS overpass time. The polluted scene can be cloud covered at over pass, but be captured by AERONET before or after, or the scene can significantly change between two observing times. It is more difficult to understand how the research algorithm could identify a pollution event on 17 days that all three AERONET stations missed.”

I also was curious why AERONET would miss 17 high pollution days that were identified by the new MODIS research algorithm. When I looked at the AERONET data and MODIS images for all 17 of these days “missed by AERONET” the reasons became clearer to me. In my opinion these days fell into four general categories: (1) Cloudy days in MODIS images (both Terra and Aqua) with a lack of AERONET data therefore these seem to me to be likely misidentification of clouds as high AOD pollution by the research algorithm. (2) Days with little or no cloud cover but and with much AOD data from AERONET in Level 2 (V3). However the AOD as measured by AERONET on these days was <1 at 550 nm, sometimes by 0.10-0.50 lower so this falls within the scatter of the research algorithm AOD versus AERONET measurements in Figure 9c of the paper. Spatial variance of AOD can explain some of this scatter so this is not all satellite algorithm uncertainty (see related category 4 below). (3) Days where there was no Level 2 AERONET AOD with AOD(550)>1, however there was L1 data

with AOD(550)>1 that the SDA algorithm identified as fine mode, therefore pollution. Eck et al. (2018) found that for the Xianghe site there were 15% of high AOD days (AOD(500)>1) in that were screened from L2 in V3 but had fine mode AOD(500)>1 in L1 data. Therefore, AERONET did detect these pollution events but the cloud screening and/or V3 QC eliminated them. This reference could be used to help explain these cases. I also include in this category days with only a few L1 data and the shortest wavelength of AOD measured by AERONET was >440 nm yet Angstrom Exponent was moderate ($\sim$1), since the limits of sun photometry prevented the measurement of the full wavelength range AOD spectra (nearly complete attenuation of shorter wavelength direct sun signal). (4) Days where there was on obvious gradient of AOD in the Beijing region from the MODIS images, therefore the higher AOD from the research algorithm could very likely come from haze that was in the region but not located over Beijing therefore the AERONET sensors could not detect it.

Days 'missed by AERONET' but identified by the research algorithm in each category (note that some days have characteristics of multiple categories): Category (1): 13, 36, 41, 45, 49, 55, 61, 78 Category (2): 40, 51, 54, 57, 58, 64, 82, Category (3): 12, 13, 55, 82, 86 Category (4): 51, 54, 58, 78, 82, 86 Cat (1) = Extensive cloud cover Cat (2) = AERONET AOD measured but < 1 at 550 nm Cat (3) = AERONET L1 data with AOD(550)>1 but no L2 data at high AOD Cat (4) = Gradient in AOD with lower AOD over AERONET sites

Obviously, I do not think that it is accurate to label these 17 days as pollution events that were 'missed by AERONET'. I suggest that you should include some of the issues I have identified above in the discussions in your paper as they may help explain some of these discrepancies between AERONET measurements and MODIS retrievals of AOD, even if you disagree somewhat with some of my categorizations.

I have one other unrelated comment. This study is a valuable seasonal investigation of high AOD events in the area around Beijing for the months of January through March 2013. The research algorithm shows significant improvement over the operational

one for high AOD events, in part due to improved earth surface characteristics classification. The AOD in June through August is much higher in the Beijing region than in winter (on average ∼50% higher), and this high AOD is often associated with significant cumulus cloud cover. It would be useful to also test the research algorithm in this same region in summer when surface effects would be less important but cloud effects (humidification and cloud processing) and cloud screening are more dominant issues in satellite retrievals. Perhaps in a follow-on study?

Please also note the supplement to this comment:
https://amt.copernicus.org/preprints/amt-2020-450/amt-2020-450-SC3-supplement.pdf

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