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Comment on amt-2022-303

Anonymous Referee #2

Referee comment on "Aerosol Optical Depth Retrievals over Thick Smoke Aerosols using GOES-17" by Zhixin Xue and Sundar Christopher, Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-303-RC2, 2022

This article demonstrates a method to retrieve aerosol optical depth (AOD) under high aerosol loading scenarios using GEOS satellite data based on one case study. The missing satellite AOD retrieval close to fire source region becomes an important issue as increasing interests and needs are drawn to wildfire events within this recent decade. There are many studies investigated this issue, e.g. (Shi et al., 2019, 2021; Mo et al., 2021, Li et al., 2015; Lu et al., 2021; Wang et al., 2007). However, only a few has potential to be incorporated into operational satellite aerosol algorithm due to that by relaxing the filtering criteria, all proposed method can have potential to introduce artifacts at other parts of the globe. That is the main reason that currently, all satellite operational global aerosol products still only retrieve partial plume. If the author can present an innovative approach that can retrieve optically intense smoke plume while maintain minimal artifacts outside of the plume region, it will be very beneficial to the aerosol and fire community. However, the method presented here still introduce high AOD values outside of the plume region (Figure 8). Further, the algorithm itself uses well-established aerosol satellite retrieval methods, which are the surface database plus LUT method, with many assumptions. These assumptions work well in some cases but may introduce large error in other. For example, if surface properties change due to vegetation cover or weather in short time period, e.g. harvesting crops, it will introduced large bias in AOD retrieval. Similarly, due to very high aerosol loading, the smoke model assumption will lead to large retrieval error as well. In this study, a generic smoke model is used which lead to bias as shown in Figure 6 lower panel, which shows that AOD-Ang underestimate at AOD < 1, and AOD-log is better but still has non-linear underestimation shown between AOD from 0.5 to 1.0. In this case some of these assumptions work well, but to generalize the approach may require a lot more work. In this paper, these are not considered at all.

Other than this main issue, the quality of the manuscript also needs large improvement. The introduction doesn't show nice flow of the story, the importance and the innovative part of the research isn't introduced. The background literature review is far less than comprehensive, especially on potential reasons that satellite algorithm fails to retrieve optically thick smoke. It is also very hard to follow the entire manuscript as there are

many ambiguous descriptions. For example, line 75 mentioned “different surface observations”. This is totally out of content and confusing as the AERONET is the only surface observations the paper had introduced. Another example is the first sentence in Methods section. It jumps right into technical details without introduce a picture of what is this algorithm is going to do and how in short sentence this is done.

Also there are places this paper is confusing due to methodology. For example, the paper continue mention the first is to calculate the missing percentage, which is not very convincing. The way of calculating the missing percentage by comparing AERONET data to satellite is also questionable, as when surface condition is not suitable for retrieval, e.g. Snow cover, AERONET will still have data but satellite cannot. The method author used will mis-categories these situations to cases that is caused by smoke plume is too thick. Other issues such as only choosing 20 UTC is also not making sense, as the one advantage of GOES data is high temporal variation. By only choosing one time frame will limit the observation geometries to certain range and cover up some of the uncertainty that can occur while applying retrieval algorithms.

Last the visualization of the results needs to be improved. Figure 3, 8, and 9 is hard to compare and adding a differences plot marking the new retrieval will be much more helpful. More error statistics can be plotted on comparisons plot other than correlations. A good correlation does not guarantee good agreement between two datasets. In this particular case, there are many other error statistics can be helpful, e.g. RMSE, BIAS, BIAS when AOD > 1., number of data that is plotted, % within EE. Also in many plots, AOD-ang is written as AOD-log, which is confusing.