A COMMENT

I read this manuscript with interest. Indeed, the title and the claims of the paper imply a next big breakthrough of the machine learning in AOD retrieval compared to “costly, inefficient and significantly less accurate” traditional algorithms based on the radiative transfer and physics. It is reasonably well-written, the figures are impressive and the claimed improvement over the EPIC UV and MAIAC algorithms is beyond any expectation. Let us give some analysis, though:

1: Aero AOD shows a global correlation coefficient of 0.9 with AERONET for 2020 and 2023 while the EPIC UV and MAIAC perform very poorly with R=0.465 and 0.39, respectively.

We published a very detailed validation analysis of MAIAC EPIC AOD in Lyapustin et al., 2021b, referenced in this manuscript. Apparently, the authors just did a formal citation without reading the paper which shows global multi-year MAIAC R=0.75-0.77. This value exceeds the real performance of Aero algorithm given by the numbers for Space- and Time-independent validation showing R=0.73-0.74. The published and presented at different science team meetings validation results for the UV algorithm from Dr. Torres are also very different from the results of this work. My question is how the authors obtained these very low R-values misrepresenting the two “physical” algorithms?

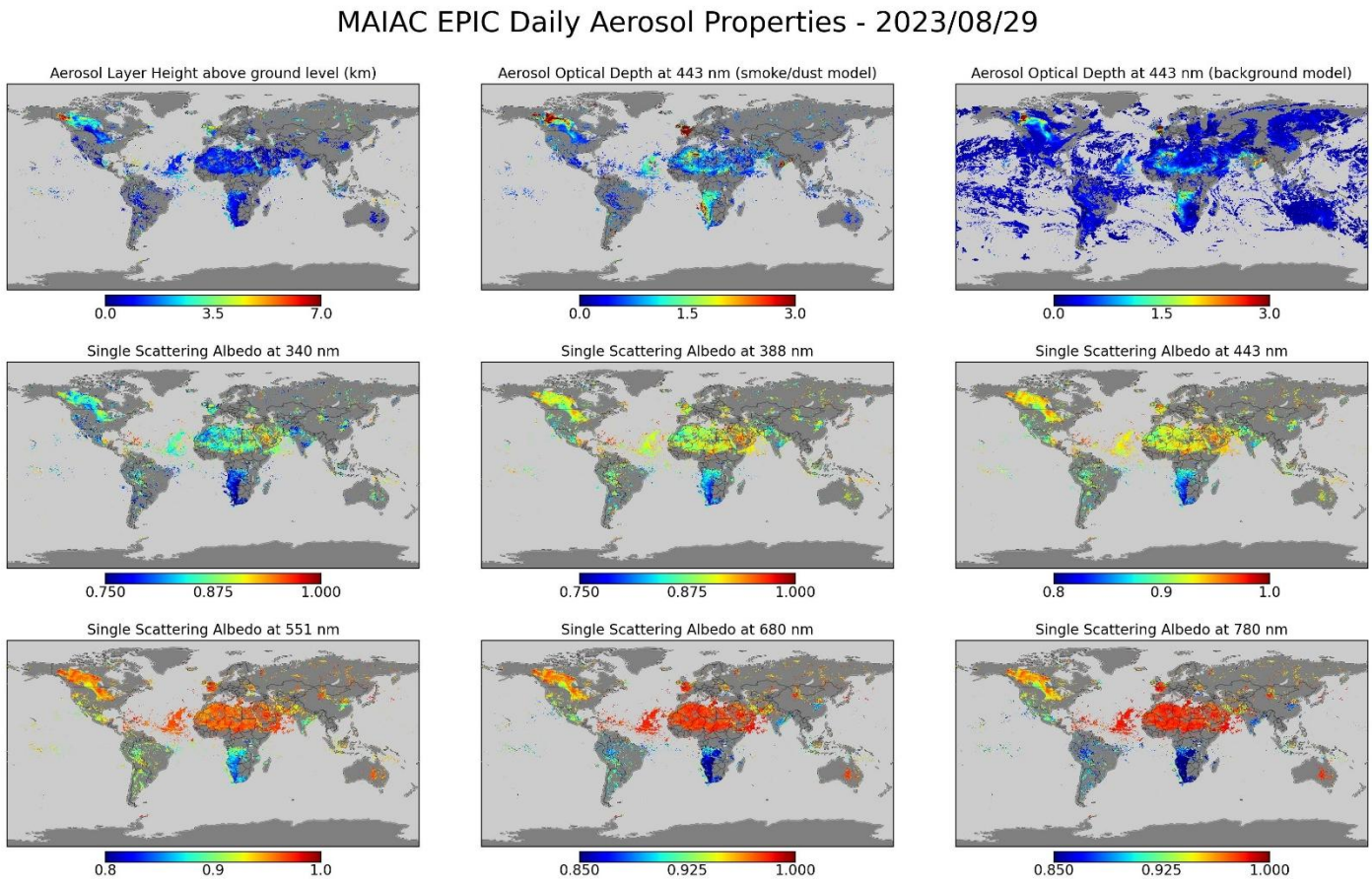
2. I was surprised to see that in Figure 5 showing global AOD for August 29, 2023, the EPIC Aero algorithm is compared with MAIAC MODIS algorithm rather than with MAIAC EPIC. Our quick check showed that MAIAC data are not available for two days of 28-29 August, 2023 because EPIC L1B data for these days were missing at the time of MAIAC processing. We have just processed these days. The daily-average MAIAC EPIC AOD (background model) for August 29 is displayed below for the comparison. It shows that MAIAC has more coverage than the Aero algorithm contrary to the (very strong) statement made in the paper (Ln. 201):

“Due to retrieval failures and algorithmic limitations, the numbers of valid collocated samples for the two physical algorithms (N = 198,004 and N =147,368) is substantially lower than DL method (N = 271,628).”

It also shows that in the emission source regions, MAIAC EPIC AOD is close to MAIAC MODIS AOD while the Aero AOD is significantly lower, which is admitted by the authors.

At this point I could formally ask - “why of all days in 2020 or 2023 the authors selected the day without MAIAC EPIC retrievals?” – though in combination with #1 I am beginning to doubt if I can trust presented results.

The image for August 29 also shows aerosol layer height (ALH) and spectral SSA retrieved by MAIAC EPIC v3 algorithm (referenced as Lyapustin et al., 2025). In total, MAIAC retrieves AOD, spectral imaginary refractive index and SSA, ALH, and provides speciation of absorbing aerosols including column volume fractions and mass concentrations of BC/BrC for smoke and hematite/goethite for mineral dust.

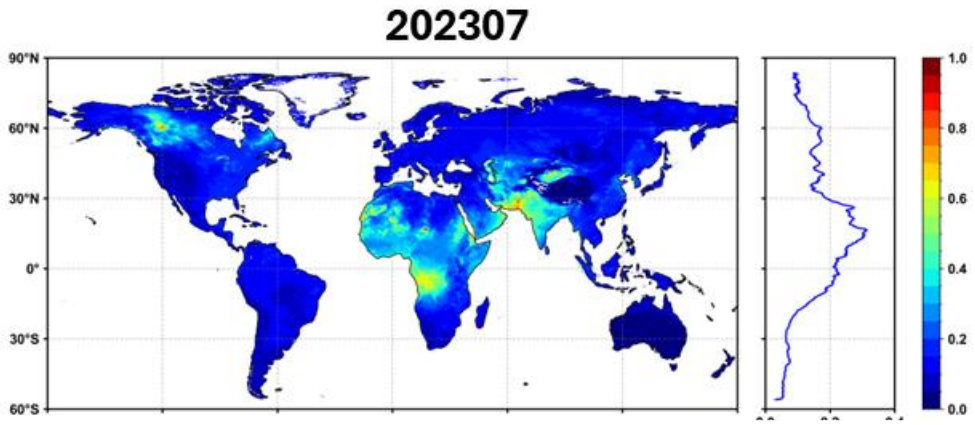


3. While the authors criticize “physical” algorithms, a knowledge of the radiative transfer and physics would benefit their research significantly. For instance, including the O2 A, B-bands or the UV bands 317, 325 nm in ML certainly reduces the accuracy of ML inference about AOD by adding unnecessary degrees of freedom uncontrolled by the ML algorithm trained on AERONET AOD. The primary use of the mentioned UV bands is for the ozone and SO2 retrieval. While there is some sensitivity to AOD, the 317, 325 nm bands have a much higher sensitivity to aerosol absorption and the height of absorbing layer because of the dominant multiple scattering. Similarly, the O2 A,B-bands depend both on AOD and ALH.

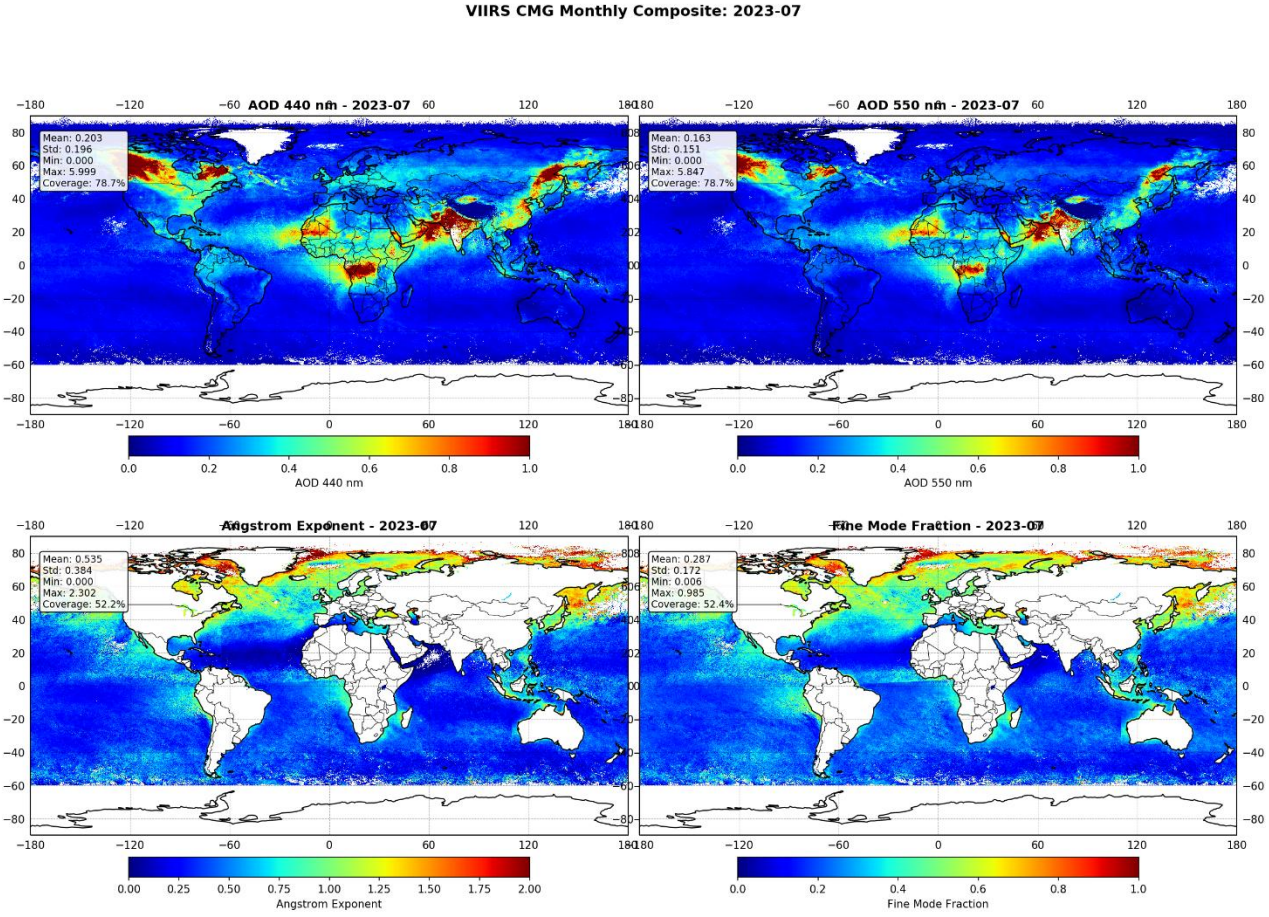
4. Figure S7 shows a very low monthly-mean AOD both globally and regionally. For instance, the maximal monthly AOD for 2023 does not exceed 0.4 in India, and 0.3 in China and south Asia. According to Aero algorithm, these regions seemingly solved their air quality problems!

Here is a comparison of monthly Aero AOD from EPIC (top, extracted from Fig. S7) and publicly available MAIAC AOD from VIIRS (bottom) for July 2023, just one month. Aero entirely misses pollution across Europe and China, fires in Siberia (this is not surprising given

lack of AERONET data to train on), and the true extent of the Canadian smoke transport over the United States.



Aero – Fig. S7 for July, 2023



MAIAC VIIRS monthly mean AOD at 0.44 and 0.55 um, along with AE and FMF (over water only).

Our validation of MAIAC VIIRS AOD shows R~0.9, RMSE~0.095 (Lyapustin et al., JGR, in review). The Aero EPIC validation in this paper allegedly gives a better statistics than that for MAIAC VIIRS, R~0.91 and RMSE=0.066.

Examples above should be sufficient. In science, we learn from the accumulated knowledge. A critical evaluation of the obtained results is a necessary part of any scientific development. Regretfully, both steps are missing from this paper.

Alexei Lyapustin

NASA Goddard Space Flight Center