RC1: 'Comment on egusphere-2026-2225', Yingxi Shi, 01 Jun 2026 reply

Paper Review: Intercomparison of Nighttime AOD Retrievals from VIIRS DNB Data

This paper evaluates and intercompares two nighttime AOD retrieval methods, a lunar reflectance-based approach and a city light-based approach, using VIIRS DNB data over Dakar, Senegal for 2017–2018. Both methods are validated against AERONET and compared with MODIS, demonstrating qualitative skill in identifying aerosol plumes. The work is timely and significant, as nighttime aerosol retrieval remains an underserved area, and the finding that combining both methods increases nighttime sampling by over 50% is a practically valuable contribution to the remote sensing community. The paper is well-written, well-organized, and the multi-source validation framework is solid.

We thank the reviewer for their time and the constructive comments provided.

Major Issues

Question: The most critical weakness is the extremely small coincident sample size, only 8 valid retrieval pairs across two years, which fundamentally limits the statistical credibility of the intercomparison. The authors should consider extending the time period or expanding to additional sites to build a more meaningful dataset. Additionally, the relationship between the lunar reflectance method presented here and the previously published algorithm from Wang et al. (2020) and Zhou et al. (2021, 2024) is never clearly established, raising concerns that whether what is presented here shows the similar quality as what is published. Finally, while moon phase is acknowledged as a major uncertainty source, its systematic impact on retrieval count and bias for each method is never quantified, a dedicated analysis of retrieval performance as a function of lunar illumination fraction is strongly recommended.

Response: Thank you very much for your comments. Reviewer 2 has a similar concern with the data volume. We took the suggestion seriously and have done a few tests. Firstly, we tried to include two new sites, Cape Verde and Mindelo OCSM that have nighttime AERONET data. However, both sites do not pass the target selection for the city light method due to either very limited city size (requires a city to be at least 40 VIIRS pixels in size), or violation of the stable light source assumption as mentioned in Zhang et al., (2025). Thus, we could not include the two sites in the study. We took the suggestion from reviewer 2, and expanded the study area for the city light method and included both Dakar and Dakar Belair sites. In addition, we added one new year (2019) of data into the analysis as the reviewer suggested. While there are still limited data points, this is likely related to the nature of the nighttime retrieval itself as both nighttime AERONET and the reflectance-based retrieval methods can only be applied to nights with moon-light. Also, stringent cloud screening methods (Zhang et al., 2025) limited the number of retrievals from the city light-based method.

We didn't use retrievals from Wang et al. (2020) and Zhou et al. (2021, 2024), as those studies are case studies over land. No operational data are available from those studies. The over-ocean reflectance-based method, developed by the authors, is attempted over dusty regions in this study, and it is different from the over land retrievals as mentioned. In fact, daytime reflectance-based aerosol retrieval methods are very matured. The nighttime reflectance-based method is rather similar to the daytime method, with the use of same surface properties and aerosol properties however the major difference is the use of TOA moon flux instead of TOA solar flux. This is also a testing topic in this study, to apply daytime retrieval method for nighttime aerosol retrievals with marginal changes.

We also added the analysis of retrieval performance as a function of lunar illumination fraction as suggested. This analysis was added to Section 4.6. We added two subplots to Figure 6 (Figure 6b and Figure 6c) dedicated to investigating retrieval performance as a function of lunar fractional illumination. Aside from the plots themselves we also added discussion related to this topic in Section 4.6.
Thank you for the excellent suggestions.

Minor Issues

Question 1). It is unclear whether the DT aerosol model parameters are spectrally averaged across the DNB wavelength range or selected at a single central wavelength, this should be explicitly stated.

Response: To avoid confusion, we added/updated the following text in Section 2.4: "For consistency in dust aerosol optical properties, we applied MODIS Collection 6 (C6) Dark-Target (DT) over-ocean algorithm values of aerosol physical properties including refractive index, effective radius, and radii standard deviation values obtained for 7 wavelengths individually that range from 0.47-2.11 µm. (e.g., Figure 1). The five wavelengths of the DT aerosol parameters used are from the 0.47, 0.55, 0.65, 0.86, & 1.24 wavelengths. Using this information, for coarse mode aerosols, T-Matrix (Mishchenko et al., 1996) calculations were performed by the research team to estimate dust optical properties including phase function, single scattering albedo, extinction cross section, and scattering cross section, assuming spherical dust. Note that the shape assumption implemented in this study is different from what is done by the MODIS team (assuming spheroids instead). This means the retrieval is assuming purely coarse mode spherical dust aerosols. This assumption may introduce larger error when AOD is low (minimal dust) and may have a better performance for high AOD cases. Next, SBDART is designed and run for simulations using optical properties such as single scattering albedo, extinction cross section, and Legrendre polynomial coefficients as provided by the T-matrix calculations at each of the seven wavelengths respectively. SBDART radiative transfer simulations were performed using discrete wavelengths from 0.49 – 0.90 µm in 0.005 µm intervals covering the spectral response range of the VIIRS DNB using the wavelength dependent optical properties from the T-matrix as explained. After which, the simulated radiances from SBDART were weighted (or spectrally averaged) by the VIIRS DNB spectral response function to produce a single-band integrated reflectance."

Question 2). Figure 2: panels (d) and (e) appear to include a glint mask while panel (f) does not; if intentional, this should be explained.

Response: We thank the reviewer for catching this discrepancy and it was not intentional to not include the glint angle mask in Figure2f. Figure 2f has been updated accordingly and now includes the glint angle mask.

Question: 3). Figure 3a is too cluttered to convey a clear message, if the intent is to show sampling differences, consider a bar chart or availability matrix; if showing time-series agreement, merge daytime and lunar AERONET into a single reference series.

*The rationale for separating 2017 and 2018 data in Figure 3 is unexplained; the terms *waxing* and *waning* should be briefly defined for general audiences.*

Response: We acknowledge the clutter evident in Figure 3a and have updated the figure. As suggested by the reviewer we merged the daytime and lunar AERONET data into a single reference dataset and changed the color and transparency of the figure to improve readability.

We added to the manuscript a description of both waxing and waning for general audiences: "Waxing conditions refer to moon phase moving from New Moon to Full Moon (illuminated portion of the Moon is growing) while waning conditions describe moon phase moving from Full Moon to New Moon (illuminated portion of the Moon is shrinking)."

Question 4). Line 337 contains what appears to be an incomplete placeholder sentence regarding the standard deviation threshold for cloud masking.

Response: We updated this sentence and removed the incomplete placeholder. The text now reads: "As the first step, we intercompare AOD retrievals from the reflectance based and the city light based AOD retrievals with a time series of solar and lunar AERONET measurements as shown in Figure 3a, where the lunar reflectance-based AOD retrievals were conducted using a standard deviation threshold of 0.01 and a cloud fraction threshold of 0.2."

Question 5). It is counterintuitive that the city light method yields fewer AERONET-paired data points than the lunar reflectance method when against lunar AERONET comparisons. This discrepancy should be explained.

Response: Both nighttime AERONET and nighttime reflectance-based method require the presence of moon-light. No nighttime AERONET data is available over nearly half of month for a given month due to the lack of sufficient moon light. That is why more collocated pairs are found over between the lunar reflectance method and the nighttime AERONET data. For daytime comparison, however, more collocated data are found between the city-light method and the daytime AERONET data. This difference can also be caused by the differences in QA and cloud screening in different methods, as well as different study domains. It is, however, hard to explore the exact reason. We added the following discussions in the text "Yet the stringent QA and cloud clearing steps (Zhang et al., 2025) also limited the number of retrievals available from the city light-based method."

Question 6). Table 1 is overly dense with redundant statistics; a simplified chart showing data count and one representative error metric would be more effective.

Response: We updated Table 1 to include the cloud screening thresholds, the data count, RMSE, and r2 value to reduce clutter and redundancies previously found in Table 1.

Question 7). Figure 4 (June 1, 2018): the flagged feature near 17–20°N, 17.5°W visually resembles a dust plume rather than cloud, additional supporting evidence (e.g., IR imagery or lidar) is needed to justify the cloud screening decision.

Response: We updated Figure 4 to include the VIIRS DNB reflectance, VIIRS Band M16 IR imagery, gridded MODIS and VIIRS AOD for June 1st 2018 and May 3rd 2018. We acknowledge that a single channel cloud detection algorithm is used to screen cloud from the VIIRS DNB retrieval. It is possible for thick aerosol plumes to be misrepresented as cloud and thus screened out of the retrieval process by the VIIRS cloud products.

Question 8). Figure 5 would be more informative if MODIS AOD were compared against lunar AERONET rather than solar AERONET, to better contextualize diurnal AOD differences.

Response: As suggested, we added the lunar AERONET comparison with MODIS AOD to Figure 5b. Furthermore, we updated the solar AERONET and MODIS AOD comparison in the manuscript to be displayed in Figure 5c.

References of note: *Wang, J., Zhou, M., Xu, X., Roudini, S., Sander, S.P., Pongetti, T.J., Miller, S.D., Reid, J.S., Hyer, E. and Spurr, R., 2020. Development of a nighttime shortwave radiative transfer model for remote sensing of nocturnal aerosols and fires from VIIRS. Remote sensing of environment, 241, p.111727.; Zhou, M., Wang, J., Chen, X., Gomes, J., Levy, R.C. and Miller, S.D., 2024, January. Link Day and Night: A Deep Learning Framework to Retrieve Global Nighttime Aerosol Optical Depth from VIIRS DNB. In 104th Annual AMS Meeting 2024 (Vol. 104, p. 435849*