

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-555

Anonymous Referee #2

Referee comment on "Satellite (GOSAT-2 CAI-2) retrieval and surface (ARFINET) observations of aerosol black carbon over India" by Mukunda M. Gogoi et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-555-RC2>, 2022

General opinion:

The authors proposed a algorithm to retrieve black carbon from GOSAT-2 CAI-2. The authors also incorporated evaluation and validation of the satellite retrievals across a network of aerosol observatories (ARFINET) over India and the findings are extended to comprehend the global BC features. Such model is in highly demand if it is proven to work effectively. However, I am more concerned about the validity of the algorithm itself because the authors did not provide enough details on the methods, equations, and uncertainties. This may prevent the readers from understanding their work. Some descriptions and discussions are sometime puzzling, and there are thus much more revisions need to be made carefully by the authors.

Major Comments

1. Inadequate innovation of the MS based on the claim of Line 40-41 " the direct retrieval of BC from satellite based radiation measurement have not addressed so far." This is really not true. Below are some articles published in recent years, proposed similar algorithm in other countries.

Bao, F., Cheng, T., Li, Y., Gu, X., Guo, H., Wu, Y., Wang, Y., & Gao, J. (2019). Retrieval of black carbon aerosol surface concentration using satellite remote sensing observations. Remote Sensing of Environment, 226, 93-108

Bao, F., Li, Y., Cheng, T., Gao, J., & Yuan, S. (2020). Estimating the Columnar Concentrations of Black Carbon Aerosols in China Using MODIS Products. Environmental Science & Technology, 54, 11025-11036

Li, L., Che, H., Derimian, Y., Dubovik, O., Schuster, G.L., Chen, C., Li, Q., Wang, Y., Guo, B., & Zhang, X. (2020). Retrievals of fine mode light-absorbing carbonaceous aerosols from POLDER/PARASOL observations over East and South Asia. Remote Sensing of

- Comprehensive literature review and rigorous discussion is required in the introduction. And some details about the satellite sensor and data should be removed from the introduction to make the introduction concise.
- the authors should give a clear description of their algorithm. In section 2.1 the authors seem to spend a lot of space to review some other scholar's algorithms, which is confusing for some cross-field. In addition, did the authors use official unpublished products? The authors mentioned that the algorithm cite an under-preparation version of CAI-2 L2 aerosol retrieval ATBD (L117). If an official unpublished product is used, then a detailed description of the algorithm is needed. If the MS focuses on the improvements to existing algorithms, the basis, formulas, and the updates in this paper should also be emphasized. These descriptions must be detailed and not misleading.
- I have a few doubts about the algorithm itself. Does the minimum reflectance strategy of surface reflectance correction in this MS consistent with that described in lines 81-85? What is the role of NDVI in this decision? In addition, if this strategy is used, it should be explained in detail in the flowchart (Fig. S1), as using 'minimum' may lead to misunderstandings.
- In addition, the authors mentioned an internal mixing model to describe the proportion of BC in the aerosol. But it is not clear which internal mixing model are used. It is necessary to state and state the formula. How is the change in absorption of BC at different wavelengths considered? How is the absorption of other non-BC particles considered? The author defines: $fbc = V_{soot} / V_{fine}$. It is also necessary to discuss the reasonableness of ignoring coarse particle aerosols. As far as I know, the spectral absorption of mixing aerosol is greatly influenced by some coarse particle (like DUST), which also show significant absorption in the near UV spectrum. These seemingly unreasonable assumptions can also have a very huge impact on later application studies.
- In the validation section I note that the authors assume a uniformly columnar distributed BC, using a simple equation for the columnar concentration and near-surface conversion, but the ideal conditions are quite different from the actual observations. I would like to see a more reasonable solution. If not, I would like to see more validation, such as SSA, BCAOD, which makes the the accuracy of the product more intuitive.
- In the comparison of Satellite retrievals vs climatological surface BC concentrations, does Satellite retrievals convert to near-ground magnitudes? If so, we need to move equation 3 here, but if not, the metrics RMSE in the validation needs to be removed, because they are two parameters with different magnitudes.
- The uncertainty analyses is missing in the MS. i.e., the uncertainty of the algorithm itself; The uncertainty of interpolation; The uncertainty of internal mixing; The uncertainty of switching columnar concentration to near ground; The uncertainty of ignoring coarse particle aerosols. The uncertainty analyses is very important for those who use the product in the future.
- How are SSA and FRP calculated in the section 2-3.3? It is not reasonable to extrapolate Indian retrievals to global FRP without extended validation and uncertainty analyses, and it may be more convincing to state Indian only.

Minor Comments

- Some paragraphs are too long, need to split and simplify
- The data in T2 and S2 for January are not matched, need double-check