

Respond to Reviewer #1

Dear reviewer, thanks for your comments. We have carefully read your comments, and replied to your comments point by point with corresponding modifications in the manuscript. In the following, your comments are marked in bold italics, our responses are in black, and the modifications in manuscript are shown in blue.

This study estimates the aerosol detect performance of DPC and verifies the accuracy of AOD retrieval with the GRASP Algorithm. It provides a complete set of DPC data pre-processing flow, and introduces the necessary information of the DPC and GRASP algorithms. In addition to the AERONET, the results of AOD were also compared with various MODIS standard aerosol products at spatial and temporal scales. Generally, the manuscript has been well organized and written. It is worthy for publication after some minor modifications. The comments were as follow. Major Comments:

Thanks for your comments and recognitions. We have carefully checked your comments and revised the manuscript. The detailed replies are as follows.

1) The DPC/Gaofen-5 is the first multiple angles and polarization satellite sensor developed by China. Thus, it is recommended to add a brief introduction to the DPC sensor in the Abstract section to help readers quickly understand the sensor.

Thank you for these suggestions. We added some appropriate additions in the Abstract to introduce the DPC sensors. We believe it is useful for readers. The specific modifications are as follows:

Line 20-25: Directional Polarimetric Camera (DPC) is the first generation of multi-angle polarized sensor developed by China. It is onboard GaoFen-5 satellite, running in 705 km sun-synchronous orbit with a 13:30 pm ascending node. The sensor has three polarized channels at 490, 670, and 865 nm and ~9 viewing angles, mainly used for observing aerosols. The spatial resolution is ~ 3.3 km at nadir and global coverage is in ~2 days.

2) For the Method section, I noticed an additional radiometric correction applied to the DPC data prior to AOD inversion. Is this necessary and does it have a big impact on the results?

Thanks for your comments. Yes, this step is important to control data quality of DPC. From the report of pervious study ^[1], the DPC reflectance has a negative bias and it can reach -20% after launch. Therefore, the retrieval of aerosols is difficult to perform without attempting to correct for these large deviations.

[1] Zhu, S., Li, Z., Qie, L., Xu, H., Ge, B., Xie, Y., Qiao, R., Xie, Y., Hong, J., Meng, B., Tu, B., & Chen, F. (2022). In-Flight Relative Radiometric Calibration of a Wide Field of View Directional Polarimetric Camera Based on the Rayleigh Scattering over Ocean. Remote Sensing, 14 (DOI: 10.3390/rs14051211)

3) As mentioned in Section 3.3, the setting of multi-pixel retrieval unit in the GRASP can help to improve result of AOD inversion. What is the basis for this setting? Does a larger inversion unit mean better inversion results?

Thanks for your comments. The size of multi-pixel retrieval units can be customized according to the experimental needs. In most cases, the setting of it depends on computer hardware conditions: the larger the retrieval unit, the larger the memory required, and the slower the calculation speed. This multi-pixel concept introduced by Dubovik et al. (2011) allows for benefiting from a priori knowledge on spatial and temporal variability of retrieved parameters and therefore helps to obtain more accurate aerosol retrieval. For example, it is well known that land surface reflectance changes very slowly in time, while aerosol properties have limited spatial variability. Some more discussion can be found in Dubovik et al. (2011, 2021) . As shown in Figure 3 in the manuscript, the increase of ambient pixels and timesteps reduces the inversion bias.

[1] Dubovik, O., Herman, M., Holdak, A., Lapyonok, T., Tanré, D., Deuzé, J.L., Ducos, F., Sinyuk, A., & Lopatin, A. (2011). Statistically optimized inversion algorithm for enhanced retrieval of aerosol properties from spectral multi-angle polarimetric satellite observations. *Atmospheric Measurement Techniques*, 4, 975-1018, doi:10.5194/amt-4-975-2011

[2] Dubovik, O., Fuertes, D., Litvinov, P., Lopatin, A., Lapyonok, T., Dubovik, I., Xu, F., Ducos, F., Chen, C., Torres, B., Derimian, Y., Li, L., Herreras-Giralda, M., Herrera, M., Karol, Y., Matar, C., Schuster, G.L., Espinosa, R., Puthukkudy, A., Li, Z., Fischer, J., Preusker, R., Cuesta, J., Kreuter, A., Cede, A., Aspetsberger, M., Marth, D., Bindreiter, L., Hangler, A., Lanzinger, V., Holter, C., & Federspiel, C. (2021). A Comprehensive Description of Multi-Term LSM for Applying Multiple A Priori Constraints in Problems of Atmospheric Remote Sensing: GRASP Algorithm, Concept, and Applications. *Frontiers in Remote Sensing*, 2:706851, doi:10.3389/frsen.2021.706851

4) In the result of AOD, the large absolute mean bias also appeared when the residual of polarized fitting is small (0.01). The reason of it should be explained in the text.

Thank you for the comment. The GRASP allows customization of the conditions for stopping iterative fitting and accounts for the noise in the input observations under assumption of that the number of independent observations is significantly larger than the number of retrieved parameters. The situation with very small polarized residuals (< 0.01) likely related with the situations when the observations cover rather narrow range of scattering range and large noise is possible. This is only an explanation that response to the abnormal phenomenon.

Another reviewer made similar observations and recommended that we revise the experiment. So, we have fixed the issue after re-performing the experiment.

Minor Comments:

1) Line 25: Abbreviations should be given full names on their first occurrence.

Thanks for the suggestion. We have fixed this issue now.

2) Line 29-32: Please rephrase the sentence.

Thanks for the suggestion. This sentence has been rephrased.

Line 33-36: Compared with MODIS products, the spatial and temporal variations of aerosol could be caught by the DPC with the GRASP/Models, showing a good performance. However, values of AOD were also underestimated by DPC, probably due to over screening high AOD event by cloud mask.

3) Line 221: The reference related Fmask is missing.

Thanks for the suggestion. We have added this reference.