Manuscript number: egusphere-2025-4208
MS type: Research article
Title: Retrievals of vertically resolved aerosol microphysical particle parameters with regularization from spaceborne Aerosol and Carbon dioxide Detection Lidar (ACDL)
Author(s): Ziyu Bi et al.
Iteration: Minor revision

Dear Editor:
We sincerely thank the editor and all reviewers for their valuable feedback that we have used to improve the quality of our manuscript. All comments have been addressed below, and modifications have been made accordingly. The point-by-point replies are listed below.
Thanks very much for considering this work! Kind regards!
Ziyu Bi
On behalf of the co-authors

Referee #3:
First, I apologize for my late answer. I have read the paper carefully and most of my previous concerns have been addressed. Now I believe the paper is suitable for publication. There is just one minor issue I would like the authors to try to address. In many previous studies of aerosol microphysical properties retrievals, it was used 355 nm. For the ACDL this wavelength does not operate, but it includes 1572 nm. That is fine. But I wonder if the lack of measurements in 355 nm could force the retrieval to underestimate the fine mode. Could this be the reason behind the large discrepancies in effective radius for urban and biomass-burning aerosols?

Responses:

We thank the reviewer for this valuable question. We agree that absence of the 355 nm may force the retrieval to underestimate the fine mode.

Indeed, 355 nm has been widely used for its strong sensitivity to submicron aerosol particles in the fine mode, and previous studies have shown that when the wavelength combination lacks sufficient spectral coverage (or the input information is limited) the inversion results trend to exhibit large errors (Veselovskii et al., 2004), and the combination included 355 nm extinction display more sensitivity to smaller particles than which without it in retrievals (Whiteman et al., 2018).

As the reviewer points out, the ACDL system does not include 355 nm and the lack of the 355 nm channel inevitably reduces sensitivity to the lower end of the fine-mode spectrum, where aerosol extinction and backscatter efficiency is significantly higher in the UV (the peak values of extinction and backscatter efficiency at 355 nm are ~0.48 μm, and ~0.92 μm, respectively) (Di et al., 2018). And when the fine mode

particles are dominant, as is typically the case for urban and biomass-burning aerosols, our wavelength combination for input optical parameters may underestimate the relative contribution of small particles and shift the reconstructed fine mode slightly toward larger radius range, which in return elevates the effective radius.

To address this issue, we have added the relevant discussion in Sec. 5.2 (lines 404) and the content is highlighted in blue font.

The revised version:

In Section 5.2 (lines 404-412):

"This is because both urban and smoke aerosols are characterized by the dominance of fine-mode particles, as indicated by the aerosol volume distributions from Omar et al. and the LIVAS climatology. In this study, the retrieval is performed based on a wavelength combination of 532 nm, 1064 nm, and 1572 nm. Compared with conventional combinations included 355 nm, which exhibits stronger scattering sensitivity to smaller aerosol particles for retrievals, with t extinction and backscatter efficiency peaks at ~0.48 μm, and ~0.92 μm, respectively (Di et al., 2018; Whiteman et al., 2018), our configuration provides reduced sensitivity to fine mode particles. As a result, the absence of the 355 nm channel may lead to an underestimation of the relative contribution of fine-mode particles and a slight shift of the reconstructed distribution toward larger radius, resulting larger discrepancies in effective radius for urban and smoke aerosols."

Di, H., Wang, Q., Hua, H., Li, S., Yan, Q., Liu, J., Song, Y., and Hua, D.: Aerosol Microphysical Particle Parameter Inversion and Error Analysis Based on Remote Sensing Data, Remote Sensing, 10, 10.3390/rs10111753, 2018.

Veselovskii, I., Kolgotin, A., Griaznov, V., Müller, D., Franke, K., and Whiteman, D. N.: Inversion of multiwavelength Raman lidar data for retrieval of bimodal aerosol size distribution, Appl. Opt., 43, 1180-1195, doi:10.1364/AO.43.001180, 2004.

Whiteman, D. N., Pérez-Ramírez, D., Veselovskii, I., Colarco, P., and Buchard, V.: Retrievals of aerosol microphysics from simulations of spaceborne multiwavelength lidar measurements, Journal of Quantitative Spectroscopy and Radiative Transfer, 205, 27-39, 10.1016/j.jqsrt.2017.09.009, 2018.