This study is ambitious. The authors extend a well-established technique for separating the fine and coarse modes of dust particles, based on AERONET data and lidar polarization measurements. In this manuscript, the authors adapt this approach for lidar measurements from space. Estimating dust particle mass concentration from an elastic backscatter lidar involves numerous assumptions about region-dependent lidar ratios, conversion factors, etc., which the authors acknowledge and discuss thoroughly. It's worth noting that the authors are well-known experts in lidar measurements. The manuscript is well-written, includes detailed introduction, long reference list, and is definitely suitable for publication in AMT. I have just several technical comments.

p.10 ln.19 “urban haze and biomass-burning smoke, with depolarizing effects of 1-4% at 532 nm”. Actually it can be much higher. Depolarization of smoke and urban particles can be up to 10%. (Veselovskii, I., Hu, Q., Goloub, P., Podvin, T., Barchunov, B., and Korenskii, M.: Combining Mie–Raman and fluorescence observations: a step forward in aerosol classification with lidar technology, Atmos. Meas. Tech., 15, 4881–4900, 2022. https://doi.org/10.5194/amt-15-4881-2022) and references therein. In upper troposphere depolarization of smoke at 532 nm can reach 15%. All this introduces uncertainties in separation of dust and smoke. Depolarization of pollen at 532 nm can reach 35%.

p.10 ln 22. “(Noh et al.; 2013)”. More recent references about pollen depolarization should be added.

Bohlmann, S., Shang, X., Giannakaki, E., Filioglou, M., Saarto, A., Romakkaniemi, S. and Komppula, M.: Detection and characterization of birch pollen in the atmosphere using multi-wavelength Raman lidar in Finland, Atmos. Chem. Phys. 19, 14559–14569, 2019. doi.org/10.5194/acp-19-14559-2019.

Atmos. Chem. Phys., 21, 7083–7097, 2021 https://doi.org/10.5194/acp-21-7083-2021

p.11 ln.1. “ In Eq. (6), "$\beta\lambda,ncd\ (z)$" and "$\beta\lambda,cd\ (z)$" correspond to the non-coarse-mode aerosol (i.e., non-dust and fine-mode dust)” I am confused. Because in p.11 ln.22 authors write “we assume mean linear depolarization effects of "δncd " and "δcd " equal to 0.16 ± 0.02 and 0.39 ± 0.03” Does it mean that smoke (it is non-dust) has depolarization 16%? These definitions should be clarified.

Fig.2. Depolarization 1.0 is confusing. Reader may have feeling that dust depolarizations extends up to 1.0

Table 4. The reference should be added:
Atmos. Meas. Tech., 16, 1951–1970, 2023 https://doi.org/10.5194/amt-16-1951-2023

Fig.5b. Labels on right axes is difficult to read.