

Authors present approach for analysis of aerosol mixture in troposphere based on observations Mie-Raman-fluorescence lidar. This is important task, but I think that manuscript needs significant revision. In particular, I am surprised, that authors don't provide any profile of particle parameters measured by lidar. This is important to prove the quality of observations. Choice of particle parameters for every aerosol type needs also strong discussion. Citation list is incomplete.

Here are some specific comments.

Table 1. Some information is not necessary, for example, lamp lifetime. If photon counting rate is up to 20 MHz, dead-time correction procedure should be mentioned (cited).

Ln.105 “For the elastic (Mie) channels, aerosol optical parameters are retrieved using the Fernald algorithm (Fernald, 1984)...” Authors measure Raman signals but use Fernald method. Should be explained why.

Section 2.2. I would recommend to cite some works of Burton et al., on mixture analysis. For example:

Burton, S. P., Ferrare, R. A., Hostetler, C. A., Hair, J.W., Rogers, R. R., Obland, M. D., Butler, C. F., Cook, A. L., Harper, D. B., and Froyd, K. D.: Aerosol classification using airborne High Spectral Resolution Lidar measurements – methodology and examples, *Atmos. Meas. Tech.*, 5, 73–98, 2012. <https://doi.org/10.5194/amt-5-73-2012>

Burton, S. P., Ferrare, R. A., Vaughan, M. A., Omar, A. H., Rogers, R. R., Hostetler, C. A., and Hair, J. W.: Aerosol classification from airborne HSRL and comparisons with the CALIPSO vertical feature mask, *Atmos. Meas. Tech.*, 6, 1397–1412, 2013. <https://doi.org/10.5194/amt-6-1397-2013>

Burton, S. P., Vaughan, M. A., Ferrare, R. A. and Hostetler, C. A.: Separating mixtures of aerosol types in airborne High Spectral Resolution Lidar data. *Atmos. Meas. Tech.* 7, 419-436, 2014. DOI: 10.5194/amt-7-419-2014

Burton, S. P., Hair, J. W., Kahnert, M., Ferrare, R. A., Hostetler, C. A., Cook, A. L., Harper, D. B., Berkoff, T. A., Seaman, S. T., Collins, J. E., Fenn, M. A., and Rogers, R. R.: Observations of the spectral dependence of linear particle depolarization ratio of aerosols using NASA Langley airborne High Spectral Resolution Lidar, *Atmos. Chem. Phys.*, 15, 13453–13473, 2015 [doi:10.5194/acp-15-13453-2015](https://doi.org/10.5194/acp-15-13453-2015)

Fig.1. Should be explained how these values were obtained. Intensive parameters of aerosols were reported in numerous publications of NASA Langley group, TROPOS group and within EARLINET. I would recommend to provide discussion and compare presented results with previous findings.

Floutsi, A. A., Baars, H., Engelmann, R., Althausen, D., Ansmann, A., Bohlmann, S., Heese, B., Hofer, J., Kanitz, T., Haarig, M., Ohneiser, K., Radenz, M., Seifert, P., Skupin, A., Yin, Z., Abdullaev, S. F., Komppula, M., Filioglou, M., Giannakaki, E., Stachlewska, I. S., Janicka, L., Bortoli, D., Marinou, E., Amiridis, V., Gialitaki, A., Mamouri, R.-E., Barja, B., and Wandinger, U.: DeLiAn – a growing collection of depolarization ratio, lidar ratio and Ångström exponent for different aerosol types and mixtures from ground-based lidar observations, *Atmos. Meas. Tech.*, 16, 2353–2379, <https://doi.org/10.5194/amt-16-2353-2023>, 2023a.

(b). Usually, depolarization ratio of smoke at 355 is higher than at 532 (works of Hu et al, for example) In Table 1 it is opposite. Why?

Depolarization ratio of different pollen was studied in laboratory:

Cholleton, D.; Rairoux, P.; Miffre, A.: Laboratory evaluation of the (355, 532) nm particle depolarization ratio of pure pollen at 180.0 lidar backscattering angle. *Remote Sens.* 14, 3767, <https://doi.org/10.3390/rs14153767>, 2022.

Type of pollen should be specified and compared with previous findings.

(c) I am surprised that uncertainty of BAE obtained for 532/1064 is lower than for 355/532.

Values at 355 and 532 nm are obtained from Raman measurements, which normally are more accurate than values obtained with Fernald method.

(d) LR for smoke at 532 nm is normally higher than for 355. Why it is opposite? Should be explained, how the values for pollen were obtained. Usually pollen are mixed with other aerosol types.

Ln.170. References for previous works, where extinction-to-volume conversion factors were presented, should be cited.

Mamouri, R.-E., and Ansmann, A.: Potential of polarization/Raman lidar to separate fine dust, coarse dust, maritime, and anthropogenic aerosol profiles, *Atmos. Meas. Tech.*, 10, 3403–3427, <https://doi.org/10.5194/amt-10-3403-2017>, 2017.

He, Y., Yin, Z., Ansmann, A., Liu, F., Wang, L., Jing, D., and Shen, H.: POLIPHON conversion factors for retrieving dust-related cloud condensation nuclei and ice-nucleating particle concentration profiles at oceanic sites, *Atmos. Meas. Tech.*, 16, 1951–1970, <https://doi.org/10.5194/amt-16-1951-2023>, 2023.

Ansmann, A., Mamouri, R.-E., Hofer, J., Baars, H., Althausen, D., and Abdullaev, S. F.: Dust mass, cloud condensation nuclei, and ice-nucleating particle profiling with polarization lidar: updated POLIPHON conversion factors from global AERONET analysis, *Atmos. Meas. Tech.*, 12, 4849–4865, <https://doi.org/10.5194/amt-12-4849-2019>, 2019.

Table 2. Uncertainties for lidar ratios should be provided.

Section 3.1. Usually ground based lidar measurements are used to validate CALIPSO results. Authors do opposite. I don't think that this is proper validation of their system. Probably section 3.1.1 is not necessary.

Ln..225. Fluorescence is provided not only by bioaerosols, but also by secondary organic particles. So particles number can be obtained from Eq.10 only for very special situations. Besides, fluorescence cross section of biological particles varies in a wide range.

I have difficulty to understand scales in Fig.3d. White spots on green background. How can I get numbers from them? Why authors don't show lidar measured profiles?

Ln.241 Need to explain how they obtained PM2.5 and PM10 values.

Ln.247. “While winter retrievals achieve the highest accuracy due to low aerosol loading...” For me it sounds strange, because it is very difficult to obtain particle parameters for low scattering ratio.

Section 3.2. Decomposition of aerosol mixture components demands high quality lidar measurements. I would suggest authors to choose several characteristic episodes and to provide lidar measured profiles of all parameters together with results of concentration retrievals. That would help reader to understand how different parameters contribute to aerosol classification.