Workshop on "Recent advancements in remote sensing and modeling of aerosols, clouds and surfaces",
GRASP ACE Summer school,
Lille, France, May 22-26, 2023

Depolarization and lidar ratio observations in Saharan dust and marine aerosol at 355, 532, and 1064 nm

Moritz Haarig[a*], Ronny Engelmann[a], Holger Baars[a], and Albert Ansmann[a]

[a] *Leibniz Institute for Tropospheric Research (TROPOS), Leipzig, Germany*

***Corresponding author e-mail**: haarig@tropos.de

Measuring the spectral slope (355, 532, and 1064 nm) of the particle linear depolarization ratio and the lidar ratio at the same time provides valuable information of the particle's properties such as shape, size and absorption, especially in the case of irregularly-shaped mineral dust particles.
For the first time, it was possible to use a Raman lidar to measure the depolarization ratio and the lidar ratio at 1064 nm in a dust plume. The rotational Raman technique was used to derive the extinction coefficient and the lidar ratio at 1064 nm. The technique was tested in the BERTHA lidar system [1] at Leipzig and is now implemented in the Polly^{XT} lidar [2] operated at Mindelo, Cabo Verde, since summer 2021.
The nighttime measurements of two Saharan dust events over Leipzig, Germany, in late winter 2021 presented in [3] are extended by further dust and marine aerosol observations at Cabo Verde, i.e., the outflow regime of Saharan dust across the Atlantic. These measurements provide the so called full 3+3+3 data set (3 backscatter coefficients, 3 extinction coefficients, 3 depolarization ratios).
In case of mineral dust, the depolarization ratio at 1064 nm decreases compared to 532 nm [1,4,5], whereas the lidar ratio increases. The results of a very strong Saharan dust outbreak (8 km thick) at Leipzig could be compared to AERONET retrieved depolarization and lidar ratios. Although AERONET results indicate a broader range, the general tendency of the lidar ratio at 1064 nm agrees quite well. The lidar ratio was previously compared between AERONET and lidar [6,7], but until now, lidar ratios could not be measured at 1064 nm with a lidar.
3+3+3 observations of mineral dust and marine aerosol will be presented and cross-checked with co-located observations of an AERONET sun photometer.

Keywords: multiwavelength lidar, optical properties, mineral dust, marine aerosol, depolarization ratio

References

[1] Haarig, M., Ansmann, A., Althausen, D., Klepel, A., Groß, S., Freudenthaler, V., Toledano, C., Mamouri, R.-E., Farrell, D. A., Prescod, D. A., Marinou, E., Burton, S. P., Gasteiger, J., Engelmann, R., and Baars, H.: Triple-wavelength depolarization-ratio profiling of Saharan dust over Barbados during SALTRACE in 2013 and 2014, Atmos. Chem. Phys., 17, 10767–10794, https://doi.org/10.5194/acp-17-10767-2017, 2017.
[2] Engelmann, R., Kanitz, T., Baars, H., Heese, B., Althausen, D., Skupin, A., Wandinger, U., Komppula, M., Stachlewska, I. S., Amiridis, V., Marinou, E., Mattis, I., Linné, H., and Ansmann, A.: The automated multiwavelength Raman polarization and water-vapor lidar PollyXT: the neXT generation, Atmos. Meas. Tech., 9, 1767–1784, https://doi.org/10.5194/amt-9-1767-2016, 2016.
[3] Haarig, M., Ansmann, A., Engelmann, R., Baars, H., Toledano, C., Torres, B., Althausen, D., Radenz, M., and Wandinger, U.: First triple-wavelength lidar observations of depolarization and extinction-to-backscatter ratios of Saharan dust, Atmos. Chem. Phys., 22, 355–369, https://doi.org/10.5194/acp-22-355-2022, 2022.
[4] 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, https://doi.org/10.5194/acp-15-13453-2015, 2015
[5] Hu, Q., Wang, H., Goloub, P., Li, Z., Veselovskii, I., Podvin, T., Li, K., and Korenskiy, M.: The characterization of Taklamakan dust properties using a multiwavelength Raman polarization lidar in Kashi, China, Atmos. Chem. Phys., 20, 13817–13834, https://doi.org/10.5194/acp-20-13817-2020, 2020.
[6] Tesche, M., Ansmann, A., Müller, D., Althausen, D., Mattis, I., Heese, B., Freudenthaler, V., Wiegner, M., Esselborn, M., Pisani, G., and Knippertz, P.: Vertical profiling of Saharan dust with Raman lidars and airborne HSRL in southern Morocco during SAMUM, Tellus B, 85 61, 144–164, 2009.
[7] Shin, S.-K., Tesche, M., Kim, K., Kezoudi, M., Tatarov, B., Müller, D., and Noh, Y.: On the spectral depolarisation and lidar ratio of mineral dust provided in the AERONET version 3 inversion product, Atmospheric Chemistry and Physics, 18, 12 735–12 746, https://doi.org/10.5194/acp-18-12735-2018, 2018.