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Aerosol and cloud typing with an automated 24/7 aerosol lidar

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Modern sophisticated multi-wavelength Raman polarization lidars have the ability to measure autonomous and unattended in 24/7 mode. These aerosol lidars can deliver backscatter, extinction, and depolarization profiles of the atmosphere which can be used for a target categorization, i.e. the determination of different aerosol and cloud types. However, to derive the optical particle properties a calibration of the lidar signals in the free atmosphere, where only Rayleigh scattering occurs, is needed. This calibration is usually done manually case by case and thus prohibits automatic data analysis and particle typing.

To overcome this limitation, the mobile EARLINET lidar PollyXT of TROPOS was deployed continuously without changes in the instrumental setup during two field campaigns in the framework of the German HD(CP)^2 project to obtain temporally stable lidar signals. The temporal stability together with the high performance and good characterization of the lidar lead to the possibility of an absolute lidar calibration. The corresponding calibration constant was derived in two ways: first by using manually Raman and Klett retrievals for selected periods and second by using the aerosol optical depth (AOD) from co-located AERONET sun photometer measurements. The derived calibration constants show a high temporal stability and a good agreement between both methods and thus allowed the continuous calibration of the lidar and the retrieval of the attenuated backscatter coefficient at three wavelengths. In addition, the calibrated volume depolarization ratio, obtained following EARLINET recommendations, is continuously available.

After correction for the molecular contribution, these four quantities were used for an aerosol and cloud typing in terms of particle size and shape. The final categorization leads to 11 categories, e.g. clean atmosphere, small spherical particles, large non-spherical particles, water droplets, ice crystals and corresponding mixtures.

In this contribution, the application of this methodology for several case studies and the statistical analysis from the two field campaigns will be shown. For future applications it is planned to implement this approach in the CLOUDNET retrieval at sites for which an appropriate lidar is available to make use of the full instrument synergy which is required for advanced aerosol-cloud-interaction studies.