Overview of the current methodologies for the retrieval of aerosol extinction and mass concentration profiles from Automated Lidar-Ceilometers

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Rationale: The retrieval of aerosol optical and physical properties from Automated-Lidar Ceilometers (ALCs) has become increasingly important, thanks to the spreading of ALC networks and their capacity to operationally provide quantitative aerosol information to the scientific and stakeholder communities. The inversion of the ALC raw signal into aerosol backscatter, extinction, and mass concentration profiles requires the employment of calibration and signal-correction procedures as well as of specific inversion algorithms. Different European research groups autonomously developed methodologies to derive these key aerosol properties, achieving significant results and data accuracy. However, these methodologies may have significantly different approaches, for example some are based on model-derived functional relationships (e.g., Dionisi et al, 2018), some on specific conversion factors and ancillary data (e.g., Mortier et al., 2013). The employment of depolarization profiles for the retrieval of aerosol mass (e.g., Ansmann et al., 2011) is also a promising strategy to exploit capabilities of polarization-sensitive ALCs. Hence, we performed a virtual mobility to review the different approaches for the retrieval of aerosol backscatter, extinction, and mass concentration profiles from ALCs. The outcome is a support document (link document) summarizing the procedures currently applied within European ALC networks useful not only for the Cost Action PROBE, but also for other European initiatives, such as E-PROFILE and the EC H2020 project RI-URBANS. The collaboration involved different research groups and institutions dealing with aerosol retrievals from remote sensing observations. The represented ALC networks are: **ALICENET** (IT), **Met Office** (UK), **V/A-Profiles** (NO, EU), **AERIS** (FR); **DWD** (DE) recently joins the initiative. Possible updates and contributions from other networks will be included (to join: PROBE ALC mailing list).

Summary table: The procedures applied within each ALC network the retrieval of aerosol backscatter, extinction, and mass concentration profiles are described, specifying for each network: 1) methodology and assumptions, 2) sources of uncertainty and expected accuracy of the products, 3) status of implementation and settings of the processing line, 4) instrumental requirements, 5) processed and potentially available datasets and 6) perspectives. A brief table is reported below (the extended table can be found in link document).

	ALICENET	Met Office	A\V-Profiles suite	AERIS
Processing line general information See extended table for input data and calibration procedure	ALICENET processing line, centralized at CNR-ISAC, https://www.alice-net.eu/	Processing on Lidarnet and DRIVE WebApp (both Met office internal) for Raymetrics, Cl61 and CHM15K. A-Profiles for CL61, CHM15k and CL31	A-Profiles (data processing, based on Mortier et al., 2013) V-Profiles (visualization)	BASIC-evolution, https://www.icare.univ-lille
Aerosol backscatter and extinction profiles	Forward Klett with model-derived functional relationship (Dionisi et al, 2018) linking aerosol extinction to aerosol backscatter and iterative technique to adjust LR profiles	Forward Klett with assumed LR (literature or Lidarnet) or constrained LR using sunphotometer when available	Forward (backward for miniMPL) Klett with assumed LR value for different pre-defined aerosol type scenarios	Bakward Klett with assumed LR/constrained LR using photometer when available, extinction in the blind zone constrained with nephelometer and aethalometer
Aerosol mass concentration profiles	Model-derived functional relationship linking aerosol volume to aerosol backscatter plus assumed aerosol density profile (uniform/variable)	Specific extinction from sunphotometer data and T-matrix calculations (for spherical-fine particles) plus assumed aerosol density. Separate backscatter profiles for spherical and irregular aerosols from CL61 VDRs	Mass extinction efficiency from assumed aerosol optical-microphysical properties and Mie code for different pre-defined aerosol scenarios	Mass extinction efficiency from sunphotometer inversion and Mie code, and assumed aerosol density