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# A model-assisted retrieval of aerosol properties from elastic backscatter lidar and ceilometer measurements

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Knowledge of the height-distribution of aerosol particles is a key factor in the study of climate, air pollution, and meteorological processes. Thanks to their low construction and operation costs and their capability to provide continuous, unattended measurements the use of automated lidar-ceilometers (ALC) for aerosol characterization has increased in the recent years. The assessment of the aerosol properties from ceilometer measurements and relevant assimilation in meteorological forecast models is amongst the main objectives of the EU COST Action TOPROF (Towards Operational ground-based PROFiling with ceilometers, doppler lidars and microwave radiometers). Concurrently, the E-PROFILE program of the European Meteorological services Network focuses on the harmonization of ceilometer measurements and data provision across Europe.
Within these frameworks, we implemented a methodology to retrieve key aerosol properties (extinction coefficient, surface area and volume) from lidar/ceilometer measurements. The method is based on results from a "Monte-Carlo" numerical model, set up to derive mean functional relationships linking the aerosol backscatter coefficients and the above-mentioned variables. These relationships allow for retrieving aerosols backscatter and extinction profiles, plus volume and surface area from single wavelength lidars. All these variables provide valuable information for visibility, radiative transfer, and volcanic risk applications.
The model-assisted retrieval has been tested using data from three ceilometers (CHM15k-Nimbus) of the Italian Automated Lidar-Ceilometer Network (ALICENET, www.alice-net.eu): Aosta Saint Christophe (ASC), San Pietro Capofiume (SPC), and Rome Tor Vergata (RTV). For each system, a one-year-record of ceilometer-retrieved Aerosol Optical Depth (AOD) has been compared to the AODs directly measured by co-located sun-sky photometers. This comparison resulted into an overall good agreement (relative absolute mean difference < 15%) at all sites. At ASC, the aerosol volume retrieved by ceilometer data in the lowermost 75 m was compared to the one measured by aerosol optical counters, showing rather good agreement too. Some discrepancies were found in the presence of high relative humidity and/or particle number concentrations, not encompassed in the numerical model.
The proposed approach will possibly represent a valid option to extend the capabilities of ALCs at providing information important to operational air quality and meteorological monitoring. Furthermore, the announced implementation of a depolarization channel in the next generation of ceilometers (as prototyped in the DIAPASON project, http://www.diapason-life.eu) will improve the capabilities of the operational aerosol profiling, providing further information on the type of particles sounded.