# ALICENET: THE ITALIAN AUTOMATED LIDAR-CEILOMETER NETWORK

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In collaboration with:

## Network


*Figure 1: Location of the ALICENET ALC instruments*

ALICENET (https://www.alice-net.eu/) is the Italian network of Automated Lidar-Ceilometers (ALCs) operationally (24/7) monitoring aerosol profiles and clouds, and contributing to the European EUMETNETE-PROFILE program. The geographical distribution of the ALICENET systems (**Figure 1**) allows investigating aerosol properties over a wide range of atmospheric and environmental contexts, affected by anthropogenic emissions (Diémoz et al., 2019a, b), desert dust advections (Gobbi et al., 2019, Barnaba et al., 2022a), and volcanic ash eruptions.

The network is coordinated by CNR-ISAC with collaboration of several regional EPAs (ARPAs) and Research Institutions. CNR-ISAC is also in charge of the centralized data processing (**Figure 2**), including data quality controls and inversions, this providing homogeneous quantitative information on aerosol properties across the country.

## Retrievals

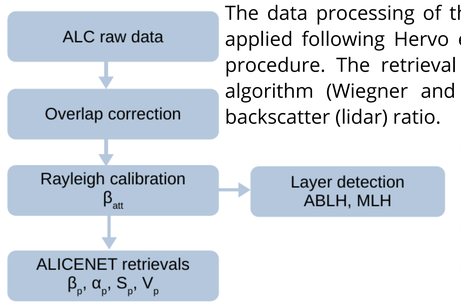


*Figure 2: Flowchart of the ALICENET data processing*

The data processing of the ALCs raw signal is as follows. First, an instrument-specific overlap correction is applied following Hervo et al. (2016). Then, the ALC calibration is performed using an automatic Rayleigh procedure. The retrieval of aerosol backscatter is based on the forward solution of the Klett inversion algorithm (Wiegner and Geiß, 2012), with an iterative technique to derive the required extinction-to-backscatter (lidar) ratio.

The retrieval of aerosol extinction, surface area and volume is based on a specifically-developed numerical model (Dionisi et al., 2018) simulating a large set of aerosol optical properties, from which mean functional relationships linking aerosol backscatter to extinction, surface area, and volume (and, via assumption of a particle density, mass) are derived. The detection of the mixing layer, the atmospheric boundary layer, and the continuous aerosol layer heights is performed with the STRATfinder algorithm (Kotthaus et al., 2020). Efforts to upgrade the ALICENET data processing and tailor its products to user needs are constantly made within the framework of EU Initiatives and Projects (e.g., the currently active EC COST Action Probe, and H2020 Project RI-Urbans).

## References

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Hervo et al., 2016, https://doi.org/10.5194/amt-9-2947-2016, 2016
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Wiegner and Geiß, 2012, https://doi.org/10.5194/amt-5-1953-2012, 2012

## Products and Applications

Vertical profiles of the range-corrected ALC signals (Level 1 profiles, resolution of 15 m up to an altitude of 15 km) are provided in near real time in the ALICENET website. Specific data processing allows retrieval of aerosol optical and physical properties (Level 2 profiles, e.g. **Fig. 3**).

Most of the instruments already have multiannual records. As an example of long-term data exploitation, the 6-year (2016-20121) climatology of the aerosol mass profiles in four sites of the network (Rome, Messina, Milano and Aosta) is shown in **Figure 4**. ALICENET retrievals of aerosol optical and physical properties are also evaluated against independent data from both long term observations (e.g. aerosol optical depths from co-located sun photometers, **Figure 5b**), and field campaigns (e.g. the EMERGE campaign in 2017, Andrés Hernández et al., 2022, Barnaba et al., 2022b, **Figure 5b, Figure 7**). Provision of the near real time dissemination of Level 2 profiles and of products on aerosol stratifications (Level 3, including the Atmospheric Boundary Layer height, e.g., **Figure 3**) is currently under development.

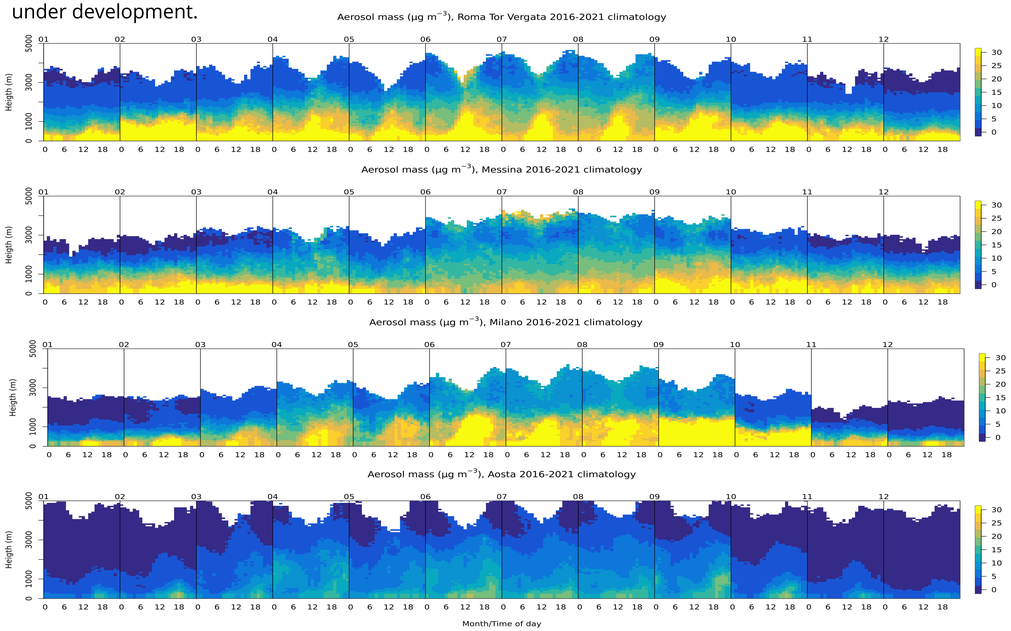



*Figure 4: 6-year (2016-2021) Climatology of the ALICENET-derived PM10 vertical profiles (Monthly and daily resolved ) at 4 sites of the ALICENET network (from top to bottom: Rome-Tor Vergata, Messina, Milano, Aosta, see also Figure 1).*

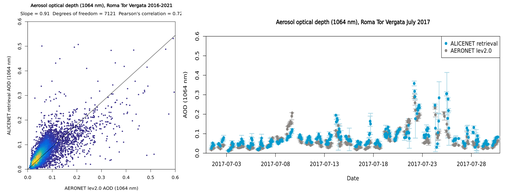



*Figure 5: Comparison between the ALICENET Level 2 AOD retrieval and the relevant reference AERONET Level 2 AOD data in Rome Tor Vergata (left: scatter plot with data in the period: 2016-2021, right: focus on a specific period (July 2017, EMERGE field campaign) to highlight the matching in the temporal variability.*

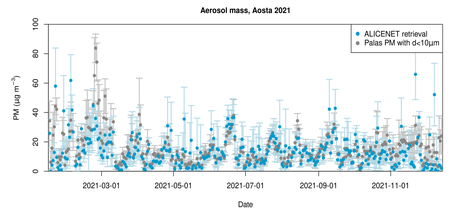
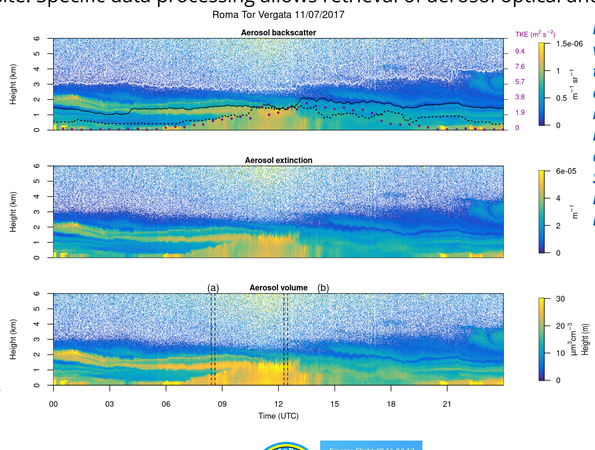



*Figure 6: Comparison between the surface concentrations of $PM_{10}$ (ALICENET retrieval and Palas OPC) in Aosta over the year 2021.*



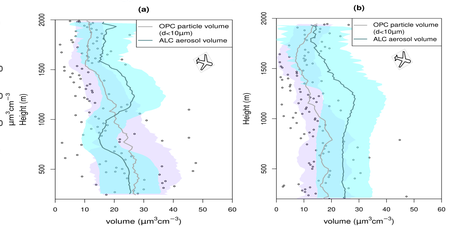




*Figure 3: Aerosol backscatter, extinction, and volume profiles in Rome-Tor Vergata derived during the EMERGE campaign characterized by the advection of Saharan dust and fires plumes. The mixing layer (dotted black line), the atmospheric boundary layer (black line), and the top of the aerosol layer (white line) heights as detected by the STRATfinder procedure are superimposed on the backscatter profiles, together with the turbulent kinetic energy time series (violet dots).*


*Figure 7: Comparison of the ALC aerosol volume profiles with relevant data from in situ aircraft measurements performed during the EMERGE campaign.*

## Conclusions

ALICENET allows continuous monitoring of aerosol vertical distribution across Italy. The long-term database already available in some ALICENET sites allows climatological analysis as well as the investigation of aerosol processes at different spatial and temporal scales. The geophysical information retrieved within the network can be tailored to a wide range of stakeholder communities, such as meteorology, air quality and aviation control agencies. An upgrade of the network and of the relevant data processing keeps ongoing in the framework of EU initiatives.

## Acknowledgements

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