Alicenet: retrievals and applications in support to urban air quality monitoring

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Alicenet network

Alicenet is the Italian network of Automated Lidar-Ceilometers (ALCs) operationally (24/7) monitoring aerosol profiles and clouds across the country, including main italian urbans sites. The network, which is constantly extending, is coordinated by CNR-ISAC with collaboration of several EPAs and Research Institutions. The data processing is centralized at CNR-ISAC, allowing the retrieval of homogeneous quantitative information on aerosol profiles.

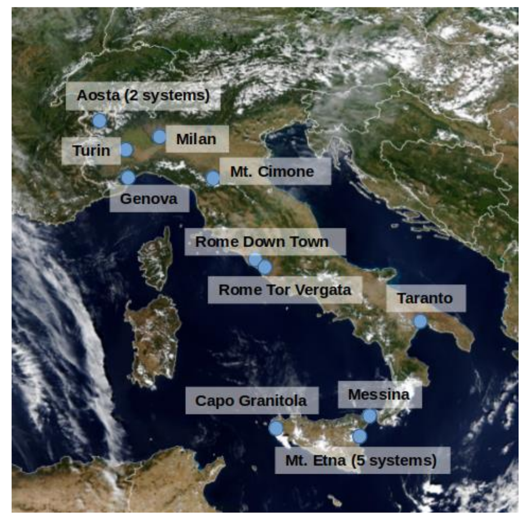


Figure 1. Alicenet sites.

Alicenet retrievals

The Alicenet retrievals are based solely on ALC data. Starting from the raw data, the full processing chain includes signal corrections and calibration procedures, and the retrieval of quantitative aerosol information, including aerosol optical properties, volume and mass concentration profiles (L2 profiles) and aerosol layer identification and loads (L2 data). More details on the retrievals can be found in [1], [2], [3]. [4], [5], [6].

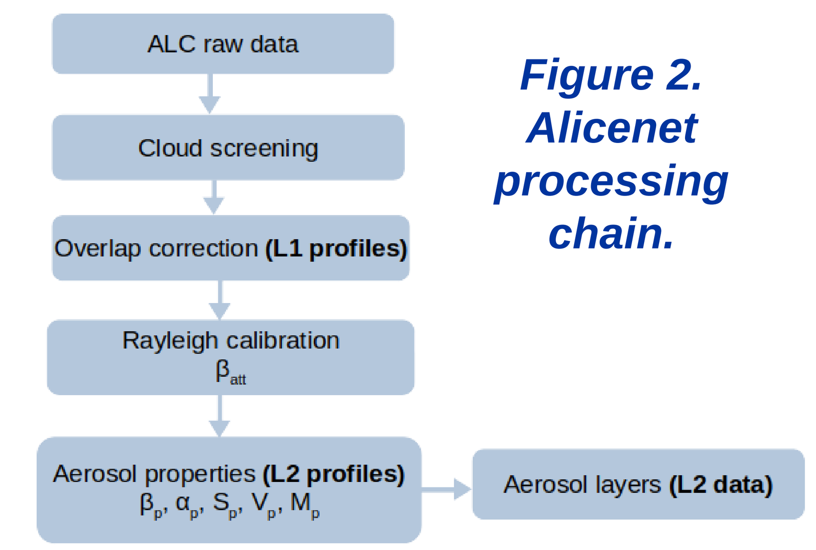


Figure 2. Alicenet processing chain.

Alicenet and RI-URBANS

Alicenet is involved in the H2020 RI-URBANS Project (WP1), with the two urban sites of Milan (Pilot) & Rome. Here, we show some applications and upscaling of the Alicenet retrievals in support to urban air quality monitoring . The chosen sites and instruments are:

- Milan, Alicenet CHM15k;
- Rome, Alicenet CHM15k;
- Paris, IPSL CHM15k, in collaboration with IPSL-SIRTA (S. Kotthaus, M. Haeffelin) in the framework of EC H2020 Projects RI-URBANS and ATMO-ACCESS.

Examples of Alicenet applications for Urban air quality: Milan and Rome

➞ **DAILY MONITORING:** Milan, 14 April 2022: entrainment of an elevated aerosol layer and the residual layer during the morning, diluted within the mixed layer and advected by mesoscale circulations during the afternoon. Both low-level dynamics impacted surface PM_{10} concentrations.

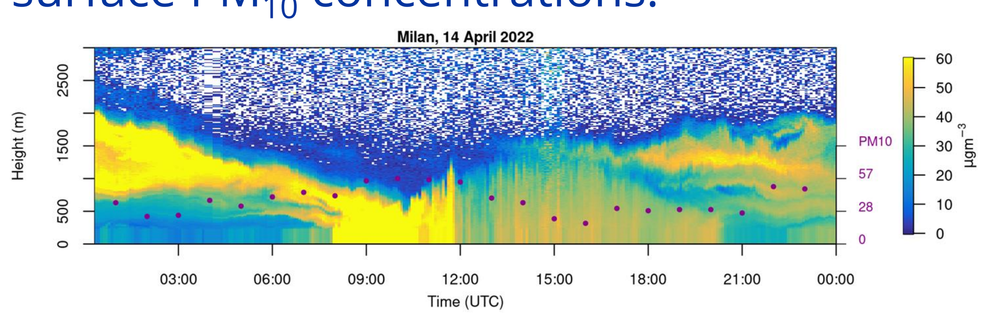
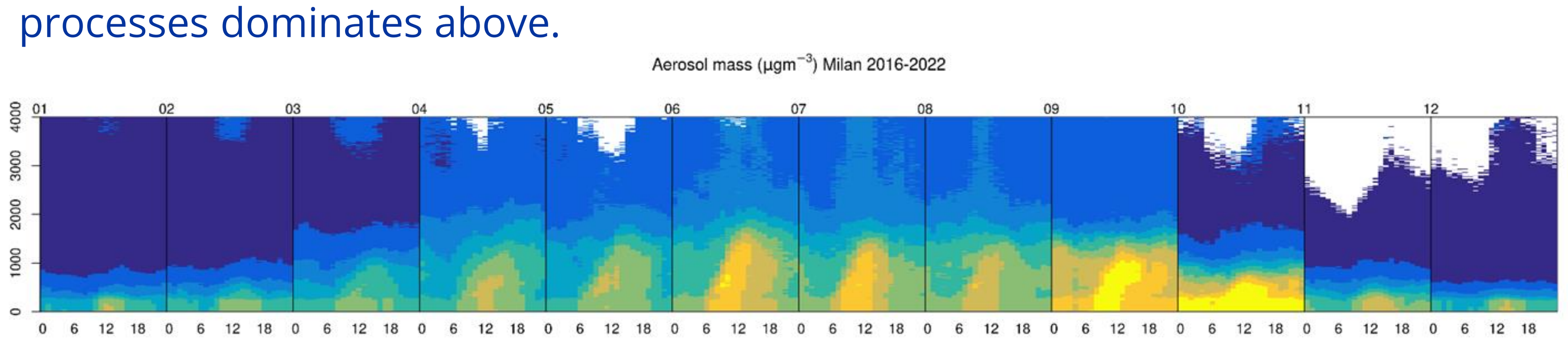


Figure 3. Aerosol mass profiles (Milan Bicocca Alicenet station) and superimposed surface PM10 (Verziere EPA station) in Milan, 14 April 2022.

➞ **LONG TERM ANALYSIS:** Milan: monthly-resolved daily cycles (hour of the day - x axis) of the aerosol mass concentration profiles (0 - 4000 m, y - axis) derived over the 7-year (2016-2022) ALC dataset (TOP panel). BOTTOM panel: Lockdown anomalies (March-May 2020) w.r.t. the long-term profiles (%). The negative anomalies due to the reduced local emissions are confined near the surface, while the influence of long-range transport processes dominates above.



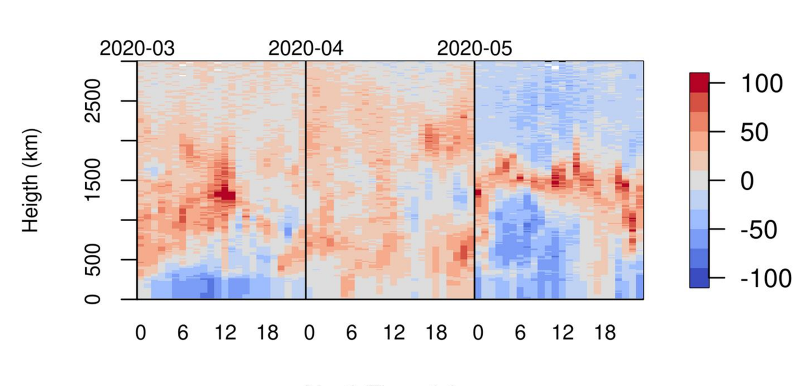


Figure 4. TOP:Long-term (2016-2022) monthly-resolved daily cycle of the aerosol mass concentration profiles over Milan. BOTTOM: Lockdown (March-May 2020) anomalies (%) with respect to the long-term profiles.

➞ **MONITORING OF TRANSBOUNDARY ADVECTIONS:** Rome, 30-31 July 2017: long-range transport of Saharan dust and fire plumes. Two elevated aerosol layers descend during July 30 and are entrained into the mixed layer on July 31, impacting surface concentrations [7].

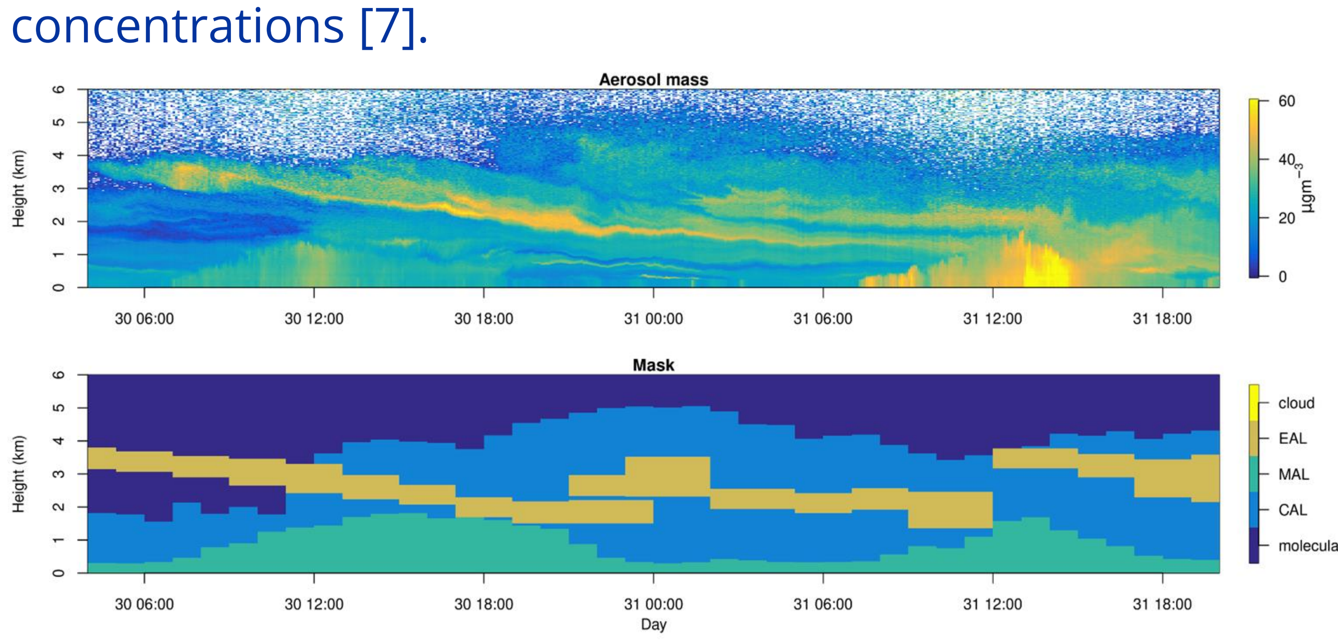


Figure 5. Top: Aerosol mass profiles over Rome, 30-31 July 2017. Bottom: Corresponding aerosol layer Mask: no aerosol (molecular atm, blue), low aerosol (Continuous Aerosol Layer, CAL, light blue), Mixed Aerosol Layer (MAL, green), Elevated Aerosol Layer (EAL, brown).

➞ **LONG TERM ANALYSIS:** Rome: (left) monthly resolved long-term statistics (2016-2022) of the occurrences of elevated aerosol layers (mostly Saharan dust), and (right) associated co-presence of high aerosol loads at the surface (entrainment from and/or capping effects of the elevated layers).

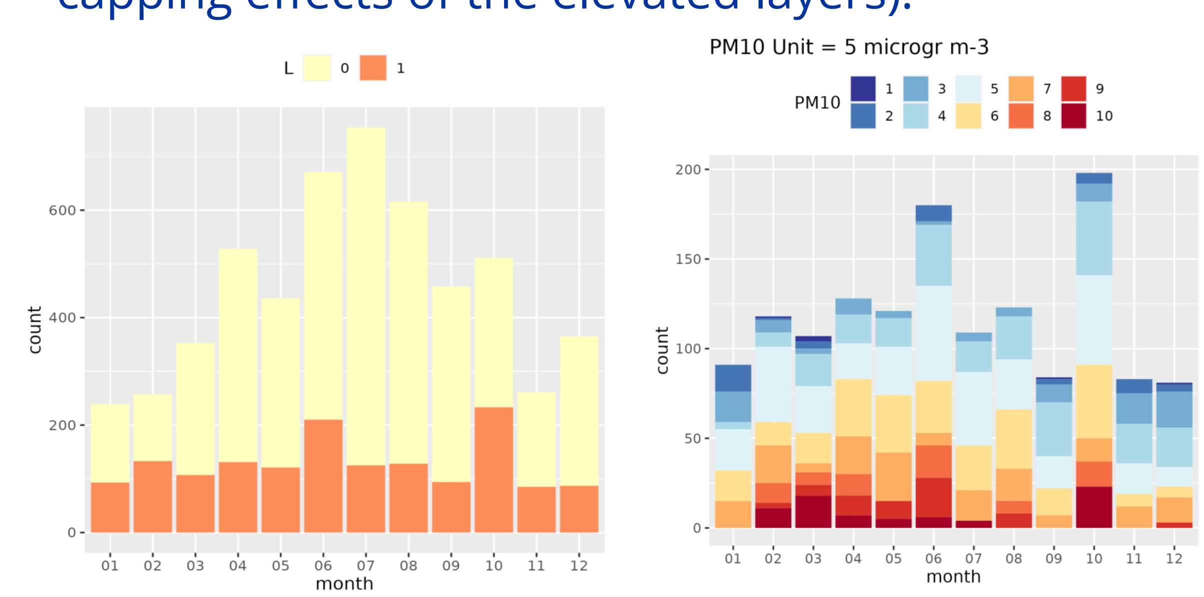


Figure 6. Left: Long-term statistics (2016-2022) of the occurrences of elevated aerosol layers over Rome (light orange, in dark orange the episodes characterized by co-presence of high aerosol load at surface). Right: Number of episodes characterized by the co-presence of high aerosol load at surface, for which surface PM10 (Cinecittà EPA station) is shown. PM10 exceedances (i.e., PM10 > 50 μg m⁻³) are highlighted in red.

Upscaling test: Paris

The Alicenet retrieval algorithms have been tested over Paris data to evaluate capability of upscaling.

➞ **UPSCALING:** Paris, 11-19 June 2022: Aerosol profiles with elevated Saharan dust layers at the end of the period. The second dust plume descends on June 17 and is entrained into the mixed layer on June 18, this leading to a marked increase in surface PM_{10} concentrations.

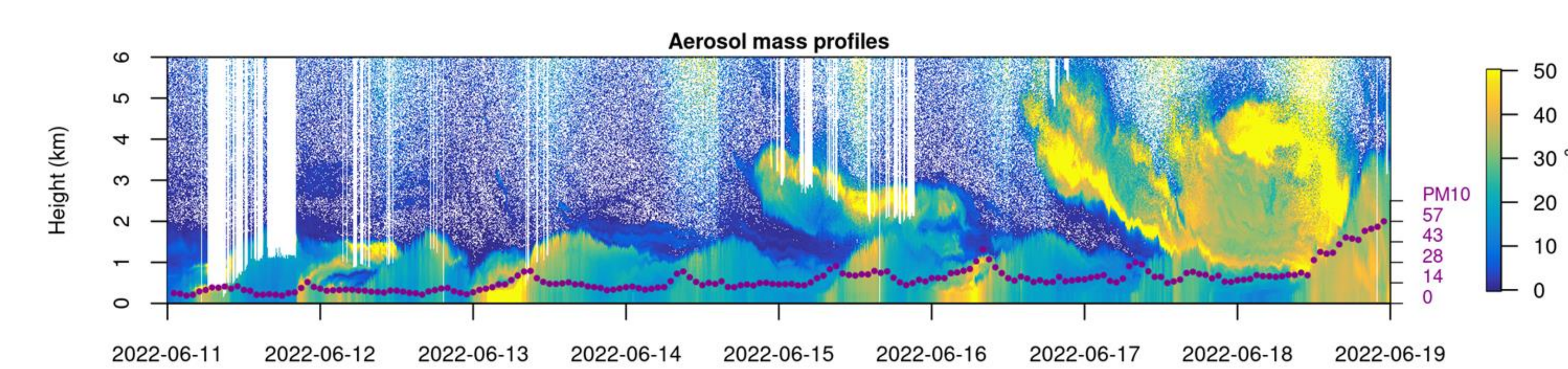


Figure 7. Aerosol mass profiles (QUALAIR-SU station, IPSL), estimated applying the ALICENET inversion algorithms, and surface PM10 (Vitry-Sur-Seine station, Airparif) in Paris, 11-19 June 2022.

see also EGU23 presentation "Urban atmosphere dynamics for air quality applications" (Simone Kotthaus et al. IPSL-SIRTA).

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Conclusions

Alicenet monitoring capacity and aerosol retrievals can effectively support air quality evaluations, particularly for: ➞ monitoring and warning systems (e.g., characterization of local and non-local aerosol sources, and aerosol transport events); ➞ long-term assessments.

References

[1] Dionisi et al., 2018, https://doi.org/10.5194/amt-11-6013-2018 [2] Diémoz et al., 2019a, https://doi.org/10.5194/acp-19-3065-2019 [3] Diémoz et al., 2019b, https://doi.org/10.5194/acp-19-10129-2019 [4] Hervo et al., 2016, https://doi.org/10.5194/amt-9-2947-2016 [5] Bellini et al., 2023, in preparation [6] Wiegner and Geiß, 2012, https://doi.org/10.5194/amt-5-1953-2012 [7] Andres Hernandez et al., 2022, https://doi.org/10.5194/acp-22-5877-2022

Acknowledgments

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