Authors reply to 'Comment on egusphere-2024-730', Anonymous Referee #1, 23 May 2024

The manuscript describes the Italian network of automated lidar and ceilometer measurements, Alicenet. The network consists of state-of-the-art ceilometers distributed from the north to the south of the country. The manuscript describes the quality control of the data and the algorithms to derive optical and physical aerosol properties, as well as a new procedure for aerosol layer identification. The derived properties are compared to AERONET AOD and in-situ measurements for validation. Long-term monitoring over seven years and several case studies show the capabilities of the network.

The algorithms used in the manuscript are based on established methods used in other lidar and ceilometer networks, but were further developed to improve the results derived from the relatively simple ceilometer instruments having only one wavelength. These algorithms have the potential to be included to the wider e-profile network and to provide further products on a European scale.

The manuscript is suitable for publication in AMT, but may be considered to be divided into a more technical and an experimental part.

We thank the reviewer for taking the time to revise our manuscript and for his/herheir constructive comments. Our point-to-point reply is given hereafter (in blue). The text lines and Figure references in our replies follow the updated numbering.

Major comments:

Did all instruments measure at all times? Or were some added later? The specific measurement periods or the start of the measurements could be added to Table 1.

Table 1 has been revised. It now also includes the beginning of measurements as usefully suggested. We believe this Table is important in the main text to give the general idea of the extension of the network, we therefore would prefer to keep it in the main text, also considering that this has been shortened as described below.

The description of the technical details of the data quality control and the algorithm development may be moved to the supplement to improve the readability of the manuscript, as already suggested by another review.

Thank you for this suggestion. We acknowledge that the subdivision between the main manuscript and the supplement was not optimal. In particular, for the algorithms description sections the submitted version had an hybrid approach, giving some details in the main text and some other in the supplement. Now, taking into account the comments by both Reviewers, we opted to restructure the manuscript so as to have a lighter main text in which the algorithms are only briefly introduced, moving all the more technical details in specific sections within the supplement. In this way, very expert readers as the Reviewers could find all the details in one place, possibly allowing them to reproduce the algorithms, while keeping the reading of the main text easier for the wider readership.

Throughout the whole manuscript: the language should be improved, sometimes this makes the understanding of the meaning difficult. Too many parentheses, as already stated in the quick review.

Thank you for this suggestion. We revised the manuscript to improve language and phrasing.

Minor comments and some suggestion:

Line 13: these -> such systems

Thank you, the sentence now reads (L12-13):

'This information is primarily derived by lidar active remote sensing, in particular with extensive networks currently in operation worldwide'.

Line 17-20: long sentence

Thank you. The sentence has been rephrased (L17-20):

'In the current configuration, the network makes use of both single-channel ALCs and dual channel, polarisation-sensitive systems ALCs (referred to as PLCs). The systems operate in very different environments (urban, coastal, mountainous and volcanic areas) from Northern to Southern Italy, thus allowing the continuous monitoring of the aerosol vertical distribution across the country'

Line 21-24: long sentence

The sentence has been rephrased (L23-25):

'In this work, we present the ALICENET infrastructure and the specifically-developed data processing centralised at CNR-ISAC, converting raw instrumental data into quantitative, quality controlled information on aerosol properties, ranging from attenuated backscatter to aerosol mass and vertical stratifications'

Line 245: Overall, this setup provides from near real-time to long-term overviews of the 4D aerosol field over Italy. ...

is difficult to follow.

Maybe rather:Overall, this setup provides near real-time as well as to long-term overviews of the 4D aerosol field over Italy.

Thank you. The sentence has been rephrased (L23-25):

'This setup allows to get insights into the 4D aerosol field over Italy with applications from near real-time monitoring to long-term analyses, examples of which are reported in this work.'

Line 27-30: long sentence

Thank you. We tried to slightly abbreviate the sentence (L29-33):

'Overall, ALICENET represents a valuable resource to extend the current aerosol observational capabilities in Italy and in the Central Mediterranean area, and contributes to bridge a gap between atmospheric science and its application to specific sectors, among which air quality, solar energy, aviation safety.'

Line 31: of the data processing tools available -> of the available data processing tools

The sentence at L30-33 was removed.

Line 32: "could usefully integrate" , what do you mean? ALC networks can integrate other EU infrastructures, or vice versa?

We removed this sentence, since it was not clear.

Some specific remarks:

Line 132: "having a sufficiently high SNR" what is sufficient? At what altitudes? Any reference in the literature?

Thank you for this comment. We intended systems that allow to probe at least up to the middle troposphere, also for calibration purposes (e.g., Wiegner et al., 2014). The sentence was modified in order to clarify this aspect (L131-133):

'...it was agreed to operate standardised systems across the network choosing the ones that allow to probe at least up to the middle troposphere, also for calibration purposes (e.g., Wiegner et al., 2014; see also Sect. 3.2)'.

Table 1 and, among others, L 135: Change CHM15K to CHM15k

Done.

Eq. (3) and line 313, where is the overbar? Below beta?

Thank you, Eq. (3), now Eq. (S3.2) in supplement S3, was updated using median(...).

Fig. 5: Are the CL values really the same? Minimum and maximum for spring and autumn, as stated in the text? I would recommend to add date and time information on top of each subplot a) and b) for easier visual identification.

Thank you for this comment. There was an error there. Figures 5a and 5b have been corrected and date and time information added.

Line 358: More specifically, an iterative procedure is used to derive $\beta p(r)$ and $\alpha p(r)$ vertical profiles.

Corrected, the sentence now reads (L119-120 in supplement S4.1):

'Operatively, an iterative procedure is applied within the forward Klett inversion to derive $\beta p(r)$ and $\alpha p(r)$ vertical profiles as follows…'

Line 391: correct notation would be: Ångstrøm

Thank you, corrected.

Section 3.4. the use of "new" names and abbreviations for the different boundary layer parts is misleading. I would suggest to use the established ones as: planetary boundary layer - PBL, mixing layer - ML, residual layer, to avoid confusion. CAL, EAL, MAL are not very common.

We acknowledge that the classification of layers based on a thermodynamic description of the atmosphere (PBL, ML, residual layer, etc.) is more established. However, as noted by other authors (e.g., Haeffelin et al., 2012), aerosols are not perfect proxies for atmospheric thermodynamics, and their concentrations can sometimes be decoupled from atmospheric dynamics. Therefore, we chose to retain the current terminology based on direct observations by the ALCs, which we find more appropriate. We have revised the text in Sect. 3.4 to clarify this choice for the reader.

Line 549 and Eq. 6: again: overbar for median and division lines are not clear.

Thank you, in the updated version we used median(...) (see Eq. S5.3 in supplement S5).

Line 749, two , ,

Thank you, corrected.

Line 705: Italian observational gap at EU level. This has been emphasised 3 times. Was there a gap before, and it is now filled since 2017?

Thank you for this comment. It was intended to emphasise the fact that in Italy the monitoring of aerosol vertical profiles is not yet coordinated by a national weather service. An effort to coordinate these activities, collect data at national level, and cooperate with the EU community was conducted by ALICENET.