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# *Interactive comment on* "Ground-based lidar processing and simulator framework for comparing models and observations (ALCF 1.0)" *by* Peter Kuma et al.

**Anonymous Referee #2**

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Recently, more and more networks of automated lidars and ceilometers (ALC) have been put into operation or have been extended mainly by weather services. These temporal and spatially very densely covered measurements of instruments from different manufacturers provide a valuable data set for the investigation of cloud bottom heights and cloud distribution. ALCs however, can also be used for the determination of the mixing layer height or physical aerosol parameters, i.e. the particle backscatter coefficient. To make use of this large amount of data for model or even satellite instrument validation, an automated way of processing these different data sets is necessary in order to have a harmonized database. In this paper, Peter Kuma et al. provide with ALCF1.0 a framework on an open source basis which addresses this deficiency. The



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Discussion paper

paper fits within the scope of GMD and needs some minor revisions before publication.

**General comments**

The paper deals primarily with comparing cloud distribution, the cloud base height and cloud layers from observations and models. However, the influence of aerosol on radiative transfer has to be considered in any case if quantitative statements are to be made. For the investigation of only the mentioned cloud parameters a calibration is not absolutely necessary except for the harmonisation of the data and to find a common cloud detection threshold. However, with a view to a next version of the framework, the already included parts such as multiple scattering, Mie and Rayleigh scattering calculations and the calibration itself provide already the basis to include the option of investigating aerosol optical properties as well.

The authors should emphasize that the focus in this version of the framework is on clouds and not on aerosol which has influence on the attenuated backscatter of observations and of simulated lidar signals.

Section 7: This is a rather long section and should be divided into subsections dealing with the different figures 4, 5-7, 8, 9-11.

Fig. 5 it seems that for some reanalyses and models the cloud layer near the ground seem to fully attenuate the signal and no clouds above can be detected whereas higher clouds are visible in the observation. This is especially true for the models and reanalyses with very coarse resolution. However, the reanalyses and models may have calculated the clouds, but they are not visible in the simulated lidar signal. Have you compared the observed signal also with cloud masks or cloud fraction of the models? Is the picture different if you would plot other subcolumns than the first one? The lidar ratio subplots in Fig. 5-7 can be omitted since they don't appear neither in the text nor in the caption.

Fig. 8: Aerosol would have influence on the lidar ratio determined with the applied

calibration method in this paper as stated on P.15 L15. Aerosol in the layers below the cloud would lead to an increase of the determined lidar ratio (decrease of $LR^{-1}$) what can be seen in Fig. 8. Because aerosol is not considered in the used models here, they are not affected. Could you please comment on how you screened the data for aerosol and is its influence somehow considered in your calculations?

**Specific comments**

1. P.2 L.4: ash is particulate matter as well. Thus, just aerosol is sufficient.
2. P.2 L.8: "aerosol optical depth" is an integrated quantitiy relying on the lidar ratio. ALCs are used to determine the particle backscatter coefficient: Change to particle backscatter coefficient
3. P.2 L.15: EARLINET is not a network of ALCs. Most of the instruments are not operated autonomously. The measurements must meet stringent quality control criteria and are performed for selected times. A better example would be PollyNET:

   Baars et al.: An overview of the first decade of PollyNET: an emerging network of automated Raman-polarization lidars for continuous aerosol profiling, https://doi.org/10.5194/acp-16-5111-2016
4. P.6 L.19: "instrument can be housed in a protective enclosure": This is not only true for the MiniMPL systems but also for the other ALCs to allow a 24/7 operation at any location.
5. P.8 L.10: As already mentioned, it should always be emphasized that the focus here is on clouds and that aerosol is not taken into account. This however would be necessary to perform the correct radiative transfer calculations in order to appropiately simulate the lidar signal.

6. P.13 L.1 and 2: Is the calibration constant a unitless quantity?

7. P.14 L.24: The cloud detection threshold of 2x$10^{-6}$m$^{-1}$sr$^{-1}$ corresponds to a particle extinction coefficient of 0.1 km$^{-1}$ if assuming a lidar ratio of 50 sr which is not unusual for aerosol. This threshold seems to me rather low and could lead to misclasification of aerosol as clouds. This is even more true in the case of the MiniMPL system which is operated at 532 nm. Could you please comment on the observed magnitudes within liquid and cirrus clouds? Why is no adaption to the wavelength needed? Would it make sense to apply a height dependent threshold with lower values at higher altitudes to account for the lower attenuated backscatter of cirrus clouds?

8. P.16 L.11: Please check the use of the different terms "attenuated backscatter", "total attenuated backscatter", "total volume backscatter coefficient" and "particle backscatter coefficient" in the text, the figure captions and labels. The measured range corrected lidar signal calibrated with the calibration constant is normally referred to as the attenuated backscatter.

9. P.18 L.17, 19, 27 and 29: Please check figure labels for Fig. 5 in the text. There are no subfigures g, h, k, i, l.

10. P.19 L.29: Again, as already mentioned, aerosol can not be neglected. Especially when using the molecular backscatter to determine the calibration coefficient, aerosol must be considered. As you can see in Fig. 9 and 10 the streak caused by molecular backscatter is too broad to retrieve an accurate calibration constant. This is mainly caused by aerosol and varying atmospheric conditions (temperature, pressure). I would omit here and in P.20 L.10 the proposal of a "new" method.

11. P.20 L.9: Fig. 10 instead of Fig. 9

12. P.20 L.21 and 24: You are only addressing the difference between day and night here for the MiniMPL instrument. However, it should be possible to make the same observation with the other devices. It would be interesting to have the difference between day and night for the other instruments as well.
13. P.21 L.11-14: see comment above
14. Fig. 9, 10 and 11: Check caption and labels for consistent use of the term attenuated backscatter (comment P.16 L.11)
15. Supplement: Some links to the plots in the tutorial seem not to be working. In the online version it is correct.

**Technical corrections**

1. P.2 L.14 and 19: ACL –> ALC
2. P.10 L.7: mostly likely –> most likely
3. P.10 L.14: no –> not
4. P.16 L.12: check unit of the threshold: m$^{-1}$sr$^{-1}$
5. P.18 L.15: show –> snow

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