Atmospheric Measurement Techniques Discussions

Interactive comment on "Aerosol profiling using the ceilometer network of the German Meteorological Service" *by* H. Flentje et al.

Anonymous Referee #1

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The paper covers a very important topic: the benefit of ceilometer-networks must be quantified to develop measurement strategies for future 4D-aerosol characterization. It will be a combination of ceilometers, advanced lidars, passive remote sensing, in-situ data, and model calculations. At present, a detailed strategy is not yet defined, therefore, the assessment of the contribution of a ceilometer-network, such as the DWD-network currently under development, is relevant.

The paper discusses this topic by means of three examples (volcanic ash, forest fires, Saharan dust). The result is, that from ceilometers the spatiotemporal distribution of aerosols can be derived (at least under many meteorological conditions). Due to missing multi-spectral information and depolarization channels, the information content of

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a ceilometer is however limited. The authors state, that further information on the aerosols (backscatter coefficient β, extinction coefficient α, mass concentration M) can only be derived if additional data are available. So far, I fully agree.

However, the authors make not sufficiently clear that the information content of the ceilometers is indeed very limited (but of course not useless). All further parameters for the characterization of aerosols are not based on ceilometer-information! So, if there is an agreement with independent data, it is due to the high quality of the auxiliary data, good estimates (maybe by accident) – but it is not the merit of the ceilometers! In particular, the auxiliary data normally are not available (in time) and/or their evaluation is time-consuming, and the used estimates might be wrong. As a consequence the error of e.g. M is enormous (and in many cases larger than estimated by the authors). These large errors should not only be mentioned in the paper, but must be clearly emphasized, as it is important to have a message to the reader which is applicable in general (and not only for a few special events). Therefore, it is absolutely necessary to be very precise in this paper, and not to mix the potential of ceilometers with the benefit of independent information. It would be fatal, if "politicians" or funding agencies get the impression that "all problems" can be solved with ceilometers! Ceilometers are indeed useful, but they cannot determine optical or microphysical properties of aerosols.

In this context, the paper has several formulations that are not as precise as they should/could be. Some typos must be corrected and the figures must be significantly improved (see below). Some sentences can be improved, maybe the authors can ask a native speaker.

As a conclusion, after revisions of the text the manuscript can be accepted.

Note: (3644/20) or so refers to page 3644, line 20

- (affiliation): to my knowledge, the first and last authors' affiliation is "Hohen-

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peißenberg"!

- (3644/4): one should avoid the term "lidar-systems"; it is a remote sensing system based on the lidar principle.

- (3644/9): "If auxiliary aerosol ..." is too euphemistic: better something like: If additional aerosol information is available (which is not always the case) and if we make several assumptions...

- (3644/13): "envisioined", typo

- (3644/17 and the rest of the paper): The mountains' name is Eyjafjöll, or Eyjafjallajökull if the volcano including the glacier is meant.

- (3644/20): Extinction and mass may not be given in the abstract, because it suggests that these numbers are found from the ceilometer data. It was an exceptional situation that a large set of independent data were available – under "normal operational" conditions it is very doubtful, that these data are available in a timely manner. Furthermore, I doubt that the required data are available at stations other than Hohenpeißenberg.

  Suggestion: "...tracked the Eyjafjoll ash layers over Germany and roughly estimated peak extinction coefficients and mass concentrations on 17 April of 4—6($\pm$2) ... and 500—750($\pm$300) μg/m^3, respectively, based..." change to something like "...tracked the Eyjafjöll ash layers over Germany. Peak extinction coefficients and mass concentrations could only be roughly estimated because high quality data from independent measurements and model calculations were available during this event. As a conclusion, in future it must be assured that the ceilometer-network is embedded in a infrastructure of whatsoever..."

- (3645/21): Ref. "Matthias et al." does not fit, better one of Bösenberg's papers.

- (3645/22): Ref. must be "Böckmann"

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- (3645/23): I doubt that MPLNET should be mentioned in a row with EARLINET; the scientific goals and the implemented quality criteria a quite different.

- (3646/10): Avoid "lidar-ceilometer".

- (3646/23): what means "about 52" instruments? is it not possible to count the systems precisely?

- (3646/24): what means "about 32" sites, see above. Why is there a difference?

- (3646/24): Fig. 1 should be Fig. 2?! Wrong references to figures happen throughout the paper.

- (3647/6): If the authors give the line width of the laser, the width of the filter should be given as well (if available)

- (3647/15): Are these improved ceilometers implemented in the DWD-network? Is it planned?

- (3647/17): "...provides profiles of particle and molecular backscattering...", could be misunderstood: they provide only the sum (as all backscatter lidars do), not each component separately.

- (3648/10): One of the problems with the AOD-calibration is, that it is only possible during daytime. This is not explicitly mentioned in the paper (or I overlooked it)

- (3649/8): "...co-located AOD observations on short notice...", is a network existing from the DWD or is it only possible at very few selected stations such as Hohenpeißenberg?

- (3649/12): What is the drawback of "largely homogeneous" layers?

- (3650/4): Fig.3 is difficult to read (borders), maybe the contrast can be enhanced.

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- (3650/4): typo: annother

- (3650/13): Ref. to Fig. 2 correct?

- (3650/26): should be backscatter coefficient, not backscatter ratio

- (3650/26): $\tau \approx 0.15$. Where is this number from?

- (3650/28): According to the mentioned webpage it seems to me, that the name of the lidar is MULIS (same as POLIS?) and the wavelength is 1064 nm and 532 nm (depolarization ratio), respectively. Here indeed the layer is visible.

- (3651/26): what is meant with "in the range of $\sigma_e \approx 6(\pm 2) \times 10^{-5}$ m^{-1} — 6(± 2) $\times$ 10^{-4} m^{-1}". This is an order of magnitude and means more or less from zero to infinity. The AOD (as given) makes more sense, however, it should be clearly marked in the figure, where the Saharan dust layer is.

- (3652/15): Fig. 8: even with a magnifying glass it is impossible to see something. The authors should select 2 or 3 sites and should provide large images.

- (3652/21): "An analysis of the optical properties...": This should be more concrete.

- (3652/23): backscatter coefficients of that order of magnitude: can they really be detected with a ceilometer? In 5 km altitude? Night or day? Temporal integration?

- (3653/1): "...smaller at 1064 nm.". Where is this information from (not from Wandinger et al).

- (3653/15): "Both the LR and the reference value may then be iterated...". In the cases discussed here, it might be difficult if different aerosol types are existing in different layer. This problem is hard to solve, so one has to live with it. But, additional errors are introduced. This error-source should be mentioned.

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- (3653/26): In the precedent paragraph it should be mentioned, that it only works during daytime, and problems might arise at low solar zenith angles when the cloud clearing sometimes fails.

- (3654/8): "...estimated in sum to...": I did not understand this. What means "in sum"? If it is only the troposphere above, it might be reasonable.

- (3654/11): Ref. to Fig 4 correct?

- (3654/19-20): How the "inferred backscatter calibration" was extended to the whole network should be explained more clearly. I understand, how it is done for Hohenpeißenberg; are AOD and nephelometer measurements available a each station?

- (3654/23): r_p: no explained.

- (3655/8): "Lidar" → lidar

- (3655/17): "...before no aerosol signal is detected..." should be rephrased

- (3655/20): a reference to DREAM should be added.

- (3655/24): The agreement of the AODs is no surprise as the ceilometer-signal is fitted to the lidar profile.

- (3656/2): How is the AOD retrieved from nighttime photometer measurements? This is impossible.

- (3656/20): "...decreased from ... 1.6 m^2/g...". It is not clear how this number is derived. From the Fig.11 a very strong variability is obvious.

- (3657/3): "Assuming that the specific extinction obtained near the surface is representative for the PBL,...": that can be accepted (though nobody can be sure), but is it valid for the elevated ash-layer as well?

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- (3657/5): Reference to ("Sect. 4.1)": I do not see these numbers there.

- (3657/22): typo: contry-wide

- (3658/10 ff): I strong recommend to delete this sentence: "Mass concentration estimates inferred for the...". The agreement is not surprising when all relevant information is taken from the instruments, that are later used for "validation".

- (3663): Give geographical coordinates of Doernick. A circle around the ash-layer would help to interpret this figure. X-axis labels are much to small.

- (3664): It's impossible to read the small cross-sections. Omit this figure or select 2 or 3 sites.

- (3666): According to the firure-caption no signals are available before 6 UTC, according to the figure it should be 5 UTC. Right panel: labels are subvisible. What is the meaning of the lower peak in 700 m above ground? Isn't it in the overlap-range? What is BSR (γ in the text!)

- (3667): what is the reason for the increase of the profile (black line) with height (even in clear sky conditions)?

- (3668) It's not necessary to show the global distribution. If possible, restrict to the relevant part; then, the distribution is visible much better. What is the wavelength?

- (3669): please mark the Saharan dust layer.

- (3670): same as Fig.2

- (3671): labels cannot be read.

- (3673): typo: nepehlometer