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Atmospheric Measurement Techniques Discussions

Interactive comment on "What is the benefit of ceilometers for aerosol remote sensing? An answer from EARLINET" *by* M. Wiegner et al.

M. Wiegner et al.

m.wiegner@lmu.de

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Introduction

We thank reviewer #3 for his/her comments and useful suggestions – they helped us to improve the paper. We repeat the points raised by the reviewer and add our comments in italics.

Point by point replies

General comments:

- This paper covers wide topics including near field overlap correction, upper limit

of measurement, and water vapor absorption. Especially the analysis on the last one is useful to understand the behavior of backscatter profile obtained by ceilometers operated with wavelength of 905 nm. Description in Section 7 seems not comprehensive, but is acceptable if further analysis will be done in some separate papers. So this article is suitable for publication in AMT after minor revision on the issue raised below.

→ *We agree with the general comment on Section 7: It is not possible to cover all aspects in one paper and to present all possible applications: As the reviewer points out, it is certainly worthwhile to discuss the use of ceilometer data in separate papers. We – and certainly other groups as well – are working on this, so that papers focussing on specific applications, e.g. the validation of transport models or automated layer detection and attribution (likely in combination with other observations) can be expected (see also review #4). Finally, we want to mention that the paper is already long (see review #1).*

Specific Comments and Technical Corrections:

- P2500 Eq(7), S_m is not explained in the text. β_m is function of z'.

  → *We have added an explanation of S_m directly after the equation, and added the z'-dependence in the equation.*

- P2502 Eqs(10)(11), integration should be done on z' (dz → dz').

  → *Thanks! We indeed forgot the prime.*

- P2502 Eq(12), asterisk should be placed just after T.

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→ *Corrected.*

- P2503 L14, is τ_p useful if upper limit of ceilometer is below tropopause?

  → *Indeed it would be best to have independent measurements of a vertical column that corresponds to the lidar range. As this is not the case, the message in Wiegner and Geiß [that was the paper the reviewer is referring to] was that comparisons of τ_p can be used for consistency checks or for constraining ceilometer retrievals, but one must be aware of the limitations. This was not explicitly repeated in this manuscript.*
  From the measurements principle of sun photometers the complete path from the top of the atmosphere to the ground (by pointing to the sun) is observed and the (total) aerosol optical depth is derived. This problem cannot be avoided, however, the contribution from the stratosphere can normally be estimated from different sources (e.g., stratospheric lidar measurements, information on volcanic eruptions), and in most cases this contribution is either negligible or reasonable estimates are known (so corrections can be made).

- P2506 L20, $\beta_{p,ref}$ appears without explanation. It should be mentioned at P2505 L29.

  → *We have introduced $\beta_{p,ref}$ as suggested in P2505, L29.*

- P2508 Eq(15), remove ":" after F.

  → *Corrected; see reviews #1 and #2 as well.*

- P2511 L4, range corrected signal is expressed as Pr^2 here, but Pz^2 is appropriate in this paper. r is repeatedly used as range (P2517 L21, P2518 L25, caption of Fig. 2).

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→ *Thanks for the careful reading. Normally, it is implicitly assumed that ceilometers and lidars point to the zenith (or the zenith angle is a few degrees only, e.g. for cirrus cloud measurements), so that range r and height z are the same (or almost the same). Here, we make this assumption, because in this paper it is not necessary to discuss slant measurements; only in section 6.1 horizontal measurements are considered. As a consequence (and to not confuse the reader) we use z throughout the paper. The necessary changes $r \rightarrow z$ have been done.*

- P2514 Eq(20), $ln(P(z)z^2)$ is more appropriate than $lnP(z)z^2$ in parenthesis.

  → *We agree and have changed this.*

- P2519 L1, Tough → Though

  → *Changed (see also review #2).*

- P2519 L11, indicate vertical resolution (number of layers) because vertical distribution of aerosols is affected by this parameter.

  → *We have added the missing information on the vertical resolution: "... with horizontal resolutions of 36 km, 9 km, and 2.25 km and 34 layers in the vertical between the surface and the model top, which is at about 19 km. The depth of the layers increases from approximately 30 m of the lowest layer to 1 km of the uppermost layer. Between 500 m and 1000 m above ground, the layer depth increases from 150 m to 250 m".*

- P2520 L18, if authors mention dust forecast, depolarization measurement should be discussed here instead of P2522 L4.

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→ *We have mentioned the benefit of a depolarization channel in Sect. 8 because corresponding systems are currently only available as prototypes and it is not clear when they will be commercially available. In Sect. 7 we refer to studies already performed and to investigations that can be made in the short-term perspective. Thus, we feel that the paragraph on depolarization measurements can remain in Sect. 8. Nevertheless, we also understand the arguments of the reviewer. As a consequence we have added the following to the end of Sect. 7.2, P2520 L18: "Such applications are a strong motivation to develop ceilometers with a depolarization channel because it will be possible to distinguish dust aerosols from other types". In Sect. 8 we have added "If commercially available these instruments will strongly enhance the capabilities of validate chemistry transport models." So, both parts of the manuscript a better linked.*

- References, remove reverse reference information at the end of each literature (e.g. 2493 at the end of Ansmann et al.)

  → *They were added by the journal. In the final AMT-version they will be removed automatically (at least I hope so, I will keep an eye on this).*

- P2539 Fig 10, same as Fig 9.

  → *Typo corrected.*

Interactive comment on Atmos. Meas. Tech. Discuss., 7, 2491, 2014.