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Interactive Comment

Interactive comment on "Comparison of vertical aerosol extinction coefficients from in-situ and LIDAR measurements" *by* B. Rosati et al.

Anonymous Referee #2

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The manuscript presents an interesting study with a valuable data set of in-situ measurements retrieved in the lower part of the troposphere, along a period that allows searching the planetary boundary layer evolution. The instrumental set up allows the study of the aerosol absorption and scattering coefficients. Special care has been paid to the consideration of hygroscopic growth effects on the scattering coefficient. This in-situ data set has been used to test the evolution of the aerosol optical properties within the lowest 700 m of the troposphere. Similarities and differences between measurements at the Earth's surface and those at different levels have been used for discussing about the evolution of the atmospheric aerosol in the planetary boundary layer. The optical properties retrieved with the in-situ procedures have been combined for describing the vertical changes of the extinction coefficient. A final comparison among these extinction coefficients and the vertical profiles of extinction coefficient retrieved from lidar measurements is presented.

The study is worthy to be published in Atmospheric Physics and Chemistry, but the manuscript requires substantial review before being acceptable for publication. In the following I include the general and particular comments that the authors must address for improving their manuscript.

General comments

In the first part of the manuscript the authors present the procedures to retrieve the aerosol optical properties from in-situ measurements. Procedures for direct measurements of the scattering coefficient (at the ground station) and the absorption coefficient (both on board the Zeppelin and at the ground station) are presented and discussed. Furthermore, explanations on the indirect procedure used to retrieve the scattering coefficient from the measured size distributions measured on board the Zeppelin are presented. Concerning this last procedure the authors must improve the text, because it is a little bit confusing (see particular comments below).

After deriving “dry” properties with the in-situ measurements, the hygroscopic growth has been considered, including measurements of growth factor with an appropriate set up. In this way the ambient aerosol properties have been retrieved from the in-situ measurements.

Getting the scattering and absorption coefficients at ambient conditions the authors combined them to get the extinction coefficient, both at the surface level and at different levels, in the new mixing layer, residual layer and developed mixing layer. At this point it is worthy to emphasize the large amount of assumptions used in some retrieval (e.g. the scattering coefficient on board the Zeppelin, the absorption coefficient at SPC based on assuming the Angström exponent retrieved on board the Zeppelin) and the impact on the retrieval of the extinction coefficient. In this sense, the authors must emphasize on the uncertainties associated to the quantities analyzed in this study.

In the last part of the manuscript, the authors try to compare these values with the lidar retrievals. For this last purpose the authors rely on an elastic lidar (the Raman night time measurements are only used for overlap corrections of the system, as they stated). This is a weak point of the manuscript, because the only way they can derive the extinction coefficient with the elastic lidar is by assuming the so call aerosol lidar ratio, LR, as a constant value for the whole aerosol profile. This is not a single task, as Table 1 reveals, because the criterion used for selecting one lidar ration is clearly ambiguous (overlapping of the ranges assigned to different aerosol together with overlap of the LRs). In this way the uncertainty of this retrieval is really large, this can lead to uncertainties around 30-50% in the retrieval of the backscattering coefficient or the scattering ratio (Figure 4 in Supplement) and to uncertainties larger than 100% in the extinction coefficient (Figure 4 in Supplement and Figure 8 in the manuscript). In this way, the comparison between remote sensing and in-situ retrievals of extinction coefficient has no sense. So, the authors must consider changing the tittle of the manuscript and reformulating the discussion on the comparison with the extinction coefficient profiles. It is evident that the large uncertainties of the extinction profiles retrieved from elastic lidars do not give reliability to the last part of the study.

Particular comments

This section includes some comments in different sections of the manuscript that require revision.

Page 18615 Line 10. The meaning of the acronym WHOPS must be presented the first time this acronym is presented.

Page 18615 Line 10. The authors must emphasize that they only retrieve the real part of the refractive index. In this sense, they must discus the limitation of this retrieval. Taking into account the single scattering albedo values retrieved in a later section, the assumption of negligible value for the imaginary part of the refractive index requires at least a comment. The retrieval of the refractive index is crucial for the retrieval of scattering coefficient on board of the Zeppelin that finally affect the quality of the retrieval of the extinction coefficient from the in-situ measurements.

Page 18615 Line 21. The text defining the Growth Factor must be corrected to be coherent with equation 1.

Page 18616. Lines 4-6. The following text is not clear: “By comparing the dry optical response (e.g. scattering cross section) with the initially selected diameter in the DMA the effective index of refraction can be inferred.” Please, explain better the procedure for deriving the refractive index.

Page 18616. Lines 8-9. The following text is also unclear: “Relating the scattering cross section of the humidified particles to the mobility diameter provides the hygroscopic GF.” Reformulate this section to help the reader to follow the procedures used.

Page 18620. Section 2.24. Please, considering the assumptions made in this section, offer an estimate of the uncertainty associated to the retrieval of the absorption coefficient at the ground station.

Table 1, is a good example of the difficulties associated to the choice of the aerosol lidar ratio, and a reason to consider the large uncertainty associated to the extinction retrieval using only elastic lidar.

Page 18624 Lines 8-14. These statements are really broad and only suggest some confidence on the retrieval of the Backscattering coefficient using Klett-Fernald algorithm (see general comment). As the authors emphasize the local effect of the lidar ratio choice on the extinction coefficient could lead to really large uncertainties, a fact that is evidenced on Figure 8. This justifies the need for a change on the title and on the way the authors focus the comparison between in-situ and lidar retrieval.

Page 18624 Section 3. Some indications on the uncertainty of the Planetary Boundary Layer Height retrieval are required.

Figure captions for Fig 4 and 7 require more details on how the figures are built. They must include description on the meaning of the squares that are presented in the text. The figure caption in itself must help to understand the figure without reading the whole manuscript.

Figure 5 includes appropriate information on uncertainties. But this figure requires additional information on the quantitative analyses of the linear fitting of the data. The comment, in Page 18627 Line 20, indicating a "very good correlation" is really ambiguous.

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ACPD

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