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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Retrieval of aerosol properties from ceilometer and photometer measurements: long-term evaluation with in-situ data and statistical analysis at Montsec (southern Pyrenees)" *by* Gloria Titos et al.

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We thank all the reviewers for their comments and suggestions that have helped to improve the quality of the manuscript. A point by point response to Reviewer1's comments is included below. Changes in the manuscript are noted between quotation marks. The new version of the manuscript with the changes tracked is included in a separate file.

Anonymous Referee #1 Comment: This paper addresses an evaluation of the aerosol



property profiles retrieved from GRASP algorithm and which uses as inputs ceilometer and sun-photometer (SPM) measurements versus in-situ measurements. The work presents different relevant aspects that show its importance and novelty. This is the first time that GRASP algorithm using as inputs ceilometer and SPM measurements (GRASPpac) has been evaluated in a long-term comparison. This new approach (GRASPpac) presents big advantages since these two instruments can be operated in a continuous and almost unattended way and its use has been expanded by networks providing much more global coverage. However, before this approach is widely used its products need to be validated as is done in this work. In addition the work have dealt with the complexity of comparing different techniques (remote and in-situ) which also cover different ranges in the Earth-atmosphere system (surface and almost full troposphere). The results presented here show a good agreement between the optical properties from techniques and larger discrepancies in the volume size distribution when fine particles are dominant. So after these comments I conclude that the paper is very interesting, well written and show the capability of GRASPpac approach to retrieve vertical information of aerosol properties based on this long-term study. I consider that this work is appropriated for Atmospheric Measurement Techniques and it should be published after some minor corrections: About the comparison: some explanations should be given about how the in-situ measurements and the GRASP profiles are compared. How many points from the lowest part of the profiles do you take? Do you average those points? What is the altitude range that they represent? The lowest part of the remote sensing profiles are always more problematic due to the incomplete overlap of the ceilometer (even if it is corrected with the overlap function provided by the manufacturer). So I consider that is important to discuss these points in the manuscript.

Answer: We agree with the reviewer that this explanation is missing in the manuscript. Since the sun/sky photometer is located at the Montsec observatory (1570 m a.s.l.) and the ceilometer is located at 800 m a.s.l., the combination of RCS from the ceilometer and sun/sky photometer measurements in the GRASP algorithm is only possible from

1570 m a.s.l. and onwards. The ceilometer RCS used as input in GRASP is normalized and averaged at 60 log-spaced points, being the first point (1/60) equal to 1570 m a.s.l. Therefore, the GRASP-derived profiles start at 1570 m a.s.l. The comparison with the in-situ measurements is therefore made at 1570 m a.s.l. and consequently the comparison is only representative of this altitude (we cannot assure that the results of the comparison are similar at higher or lower altitudes since the in-situ measurements are limited to a single point). Also, we agree with the reviewer that the lower part of the remote sensing profiles are always more problematic due to incomplete overlap issues, and this might affect the comparison. However, since the overlap of the telescope and laser beam is greater than 85% at the height of the MSA station (1570 m a.s.l.), this effect is expected to be low. We have discussed these points with more detail in the revised version of the manuscript.

Section 2.4.: It has been modified as follows: "The ceilometer is located at 800 m a.s.l., at the Center for the Observation of the Universe (COU, http://www.parcastronomic.cat/). The horizontal distance between the ceilometer and the MSA station is less than 2.5 km."

Section 4.1.1.: We have included: "The comparison has been performed at 1570 m a.s.l., where the in-situ instrumentation is located and coinciding with the first height of the GRASPpac retrievals. Therefore, the following results and associated discussion on the comparison between GRASPpac and in-situ measurements refer exclusively to this height."

Section 2.4: we have modified it as follows: "The RCS profiles provided by the instrument are overlap-corrected using the manufacturer's overlap function. In addition, according to this function, the overlap of the telescope and the laser beam is greater than 85% at around 770 m a.g.l. Thus, the effect of the overlap at the height of the MSA observatory (1570 m a.s.l.) is expected to be low."

Section 3: we have included: "As mentioned before, the RCS profiles provided by the



ceilometer are overlap-corrected and, according to the manufacturer's overlap function, the overlap of the telescope and the laser beam is greater than 85% at the MSA altitude (770 m above the ceilometer). Thus, the effect of the overlap in the GRASPpac retrievals is expected to be low, since the ceilometer RCS below 1570 m a.s.l. is not used here as input in GRASPpac."

Comment: Looking at the histograms presented in Figure 2 I have the impression that the distributions of the relative differences are bounded to a certain positive value, how do you explain that there are no observations with discrepancies larger than +1%?

Answer: Histograms presented in Figure 2 show the relative difference between in-situ measurements and GRASP derived optical variables, taking the in-situ measurements as reference (calculated as the difference between in-situ and GRASPpac values divided by the in-situ value). We agree with the reviewer that the relative difference seems biases to lower positive relative errors. To avoid this, we have replaced relative difference by absolute difference (in-situ minus GRASPpac values) in Figure 2 and Figure 4, as well as the related discussion in the manuscript. We think that these new figures provide a better idea on the difference between GRASPpac and in-situ measurements.

Comment: Page 2, line 30: it should be also indicated that ceilometer provides continuous measurements, in contrast with most of the "more sophisticated" lidar systems.

Answer: Done.

Comment: Page 4, line 22: I wonder why you use Aeronet data level 1.5. For this long-term study level 2 data (quality assured) should be available.

Answer: We use Level 1.5 data because typically Level 2.0 data is not available after one year, when the post-calibration of the photometer is done. GRASPpac has the potential to derive aerosol properties in near real time if it is feed with Level 1.5 Aeronet data, but not if Level 2.0 data is used. Hence, we think that the study of the

performance of GRASPpac feed with Level 1.5 data is more interesting than with Level 2.0 due to the near real time implications.

Please also note the supplement to this comment:
https://www.atmos-meas-tech-discuss.net/amt-2018-431/amt-2018-431-AC2-supplement.pdf

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