Referee comments **on "LOAC: a small aerosol optical counter/sizer for ground-based and balloon measurements of the size distribution and nature of atmospheric particles: 1. Principle of measurements and instrument evaluation" by J.-B. Renard et al.**

General comments

The paper describes a new designed optical particle sizer/counter, the LOAC: the instrument presents a number of characteristics and novelties with respect to traditional instruments which makes it very interesting to be used not only on ground but also under meteorological and stratospheric balloons as well as on unmanned aerial vehicles. Besides that, exploiting and combining the measurements at two scattering angles, the LOAC is committed to be capable not only of retrieving the particles size distribution but also of estimating their nature. The main objective of this paper is to present the instrument and its principle of measurement, and to compare its performance with other conventional instruments to validate it.

The language of the paper is fluent and precise and the overall presentation of the paper is well structured and clear.

The paper addresses relevant scientific questions within the scope of this journal, presenting a novel tool working under the "theoretical" basis of the previous work of Lurton et al. (2014) published in this same journal. However, the authors seem to be very convinced and self-confident of the validity of their instrument and they do not seem very critical in this presentation of the instrument. Given that the instrument presents a number of advantages and innovations, but also some drawbacks, they should provide here a more objective evaluation of the capabilities and limitations of the LOAC. Moreover, they should also present an evaluation of the technical characteristics of the instrument (e.g. final uncertainty resulting from all the uncertainties provided for single aspects of the measurements). The results provided here are not enough to clearly support their confidence that the LOAC does not present any biases. This is of course also reflected in the abstract and in the conclusions of the paper.

The paper presents many figures, some of which could possibly be put in the Supplementary Material or eliminated (e.g. Figure 1).

Overall, the number and quality of references seems almost appropriate, even though some references are missing especially but not only in the Introduction section.

Finally, I would also be very curious to know the answer of the authors to the discussion comment by Dr. Roberts.

Specific comments

1. Page 9995, lines 1-24: The abstract should contain not only the advantages and novelties of this instrument, but also its main drawbacks, as well as specific data regarding its uncertainties, detection range and requirements of the environment where it has to be used (for instance, number of particles).

2. Page 9995, lines 23-24: This sentence is not completely correct, since some disagreements with conventional optical counters are observed. Here it would be better to soften the statement.
3. Page 9996, lines 1-13: In the first paragraph the effect of aerosols on climate is repeated twice, once for its general effects in the atmosphere, and once for its effect in the stratosphere a few lines below. Why? I would suggest reformulating this entire paragraph covering all the different effects of aerosols (health, visibility, climate, …), and regarding why it is still very important to study aerosols developing new instrumentation, in a more logical way.
4. Page 9996, line 15: This sentence is not correct since the residence time of the aerosols is not always short, depending on various factors such as precipitation most of all; moreover, the residence time of the aerosols is also not constant with height in the atmosphere, with a well-known increasing pattern with height.
5. Page 9996, lines 15-17 and lines 18-19: Many observation and monitoring systems have already been developed; make some references at least in one of these two sentences.
6. Page 9996, lines 22-24: Since the list of the references is not complete, it would be better to either add "e.g." at the beginning of the list either extend the list to cover the most important references.
7. Page 9997, lines 25-29: "less sensitive" is not equal to "not-dependent": I would suggest putting less emphasis on the complete absence of sensitivity in this region in the second sentence.
8. Page 9998, lines 5-6: You should cite that you will describe the correction for the stray-light contamination offset further on in the paper.
9. Page 9999, line 23, and Figure 1: Figure 1 is actually not needed so it can be put as Supplementary Material or removed.
10. Page 10000, lines 6-7: It does not change anything, but if the 55-65° scattering angles is the 60° channel, then for coherence the 12-16° would be the 14° channel…
11. Page 10001, lines 15-16: It is not completely clear in the answer to the referee #1 comments why the 60° channel does not need to be calibrated. This reason has to be better clarified in the text.
12. Page 10002, lines 11-13: How do you ensure that such particle concentrations are present during real measurements? Does the event that such particle concentrations are not present imply any biases or limitations of the use of the instrument?
13. Page 10002, lines 14-19: Are there any references for these values?
14. Page 10004, lines 9-11: This sentence is not clear enough.
15. Page 10004, line 27: "In fact" is not correct here since this sentence seems to the previous one.
16. Page 10006, lines 10-11: This sentence is not clear enough.
17. Page 10011, lines 10-23: It is not clear how the ascent speed of the balloon is taken into account as you answered to referee #1 comments. You report here the sampling efficiency calculations for only one ascending speed.
18. Page 10012, lines 21-26: This validation is important for the use of the LOAC in many environments where it is committed to be used. I am not convinced this validation can be omitted before presenting (and selling) the instrument to the scientific community, and using it for real measurements.
19. Page 100013-10022: It would be interesting to see the results of the cross-comparison of the LOAC with other instruments not only in terms of time series/profiles, but also in terms of regression lines (maybe to be put in the Supplementary Material).

20. Page 10013-100017: There are some other rather famous optical counters which could be used to compare and check the behavior and performance of the LOAC (e.g. Grimm, TSI, …), possibly not affected by undercounting like the WELAS (page 10014, lines 14-16).
21. Page 10014, lines 27-29: Is it not possible that this disagreement between the LOAC and the WELAS is also due to errors or weaknesses of the LOAC itself? From here it is not possible to be sure that the disagreement is only due to the WELAS undercounting. For this reason it would be perhaps better to compare with an instrument not affected by undercounting.
22. Page 10015, lines 20-23: Are there any references to cite for this sentence?
23. Page 10016, lines 4-5, and Figure 15: Actually the LOAC seems to have missed most of the concentration peaks apart from those in the 0.5-0.7 μm range.
24. Page 100017, lines 9-10, and Figure 16: Actually only the volume size distributions are shown.
25. Figure 16: The 2nd panel actually shows less agreement between the LOAC and AERONET which should be pointed out. Moreover, it is worth to point out here that the AERONET retrieved size distribution result from the Dubovik and Nakajima inversion algorithms (Nakajima et al., 1983, 1996; Dubovik and King, 2000; Dubovik et al., 2000). These retrievals are affected by uncertainties and limitations; in particular fine particles with a mode radius < 0.05 μm for the smallest mode and large particles with a mode radius > 10 μm for the largest mode cannot be retrieved with an acceptable accuracy even in error-free conditions (Reid et al., 2003). The increase of the errors for both cases of very small and very large particles can be explained by the fact that the contribution of these particles to the measured optical characteristics is significantly smaller than for particles of intermediate sizes ($0.1 < r < 7$ μm). Therefore AERONET retrieved size distribution cannot be used as an absolute reference here.
26. Page 10017, lines 18-22: Since there are some disagreements between the instruments in these cross-comparisons, it would probably be better to use less strong sentences here.
27. Page 10018, lines 9-12, and Figure 17: There are some disagreements between the LOAC and the WALI at higher altitudes, possibly due to a lower sensitivity of the LOAC. In addition, you should include your answers to the other referee comments.
28. Page 10018, line 7: Indicate some references for the index.
29. Page 10019, lines28-29, page 10020, lines 1-7: These limitations of the LOAC (among others) should be repeated in the conclusions and perhaps in the abstract.
30. Page 10021, line 14: Explain briefly why you used a density of 0.0 g cm^{-3} for water droplets: without explanations, a reader could be astonished for this value.
31. Page 10023, lines 4-14: Besides the advantages and novelties of the LOAC, summarize also its main drawbacks and uncertainties.
32. Figure 10 and 11, captions: Are the LOAC uncertainties indicated total values considering all the aspects (calibration, reproducibility, sampling efficiency)?
33. Figure 19, captions: Please insert the coordinates of the location of the sampling.

Technical corrections

1. Make sure to change overall along the paper “typology” to “topology”.
2. Page 10000, line 9: Replace “with” with “of”.

3. Page 10000, lines 15-17: Rephrase: "…, a real-time correction is needed for the high stray light contamination at small scattering angles. For this reason, …"
4. Page 10001, line 6: Remove "on the".
5. Page 10002, line 22: Remove "are".
6. Page 10002, line 23: Replace "multiply" with "multiplied".
7. Page 10003, line 15: Replace "with" with "on".
8. Page 10003, line 19: Replace "uncertainties" with "uncertainty".
9. Page 10004, line 3: Add "to" before "the".
10. Page 10006, line 9: Replace "are" with "is" or rather omit the verb.
11. Page 10007, lines 8-11: Rephrase: "For instance, … Such atmospheric temperature variations can cause a change in the electronic offset with time."
12. Page 10007, line 20: Replace "they are" with "the particles".
13. Page 10008, line 7: Delete "are".
14. Page 10008, line 10: Replace "later" with "latter". Delete "will".
15. Page 10009, line 19: Rephrase: "… but the database is still evolving."
16. Page 10011: Replace "long" with "length".
17. Page 10012, line 16: Move "has" before "always".
18. Page 10012, line 23: Replace "from" with "for". Replace "It" with "This effect". Replace "could" with "should".
19. Page 10013, line 4: Replace "are" with "have been".
20. Page 10013, line 5: Add "and" before "many".
21. Page 10015, line 4: Remove the dot after "sizes". Add "the two instruments" before "disagree".
22. Page 10017, line 11: Missing dot after "concentrations".
23. Page 10018, line 12: Substitute "in" with "on".
24. Page 10020, line 4: Modify "exhibits" into "exhibit".
25. Page 10023, line 14: Modify "from" with "obtained on".
26. Figure 11: The Figure could be enlarged.
27. Figure 11, captions: Remove "good agreement between the instruments"; "poor agreement"; "The WELAS probably underestimates sub-µm particles (Heim et al., 2008)".
28. Figure 12: The Figure could be enlarged.
29. Figure 13, captions: Remove "The WELAS probably underestimates sub-µm particles."
30. Figure 14: The Figure could be enlarged.
31. Figure 16: The Figure could be enlarged.
32. Figure 17: The Figure could be enlarged.