

Interactive comment on “LOAC: a small aerosol optical counter/sizer for ground-based and balloon measurements of the size distribution and nature of atmospheric particles – Part 1: Principle of measurements and instrument evaluation” by J.-B. Renard et al.

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We want to thank the referee for its nice and detailed analysis of our paper. Before submitted a revised version of the paper and to answer to all of its comments, we want to discuss some points raised by the referee.

1. Introduction.

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Page 9998 line 20: Indeed, we will change “typology” to “topology”. The scattering properties of particles depend on the size, on their shape and on the real and imaginary parts of their refractive index. Many laboratory studies (e.g. the Amsterdam and Granada light scattering databases, the PROGRA2 database) have shown that the imaginary part of the index, and thus the transparency of particles, strongly affect the light scattered by levitating particles.

2.1 Instrument concept:

Figure 3: We agree that the maximum concentration that LOAC can obtain is lower than most of the others instruments. But the LOAC limit, without applying the correction method presented on Figure 6 and in part 2.3, is far beyond from typical concentrations in ambient air. LOAC cannot be used in dense smokes, but can be tentatively used in fog and clouds when the dense concentration correction is applied.

2.2 Calibration:

Page. 10001 line 15: The determination of the LOAC speciation index is based on a comparison between the two angles channels (12° and 60°). Thus, the two channels must have the same calibration.

Page 10003, lines 18-25 and Figure 4: We will provide a new figure (here Fig. 1) on which the electronic offset is removed, to better present the calibration for the small diameters. The “Mie LOAC” curve is the Mie theoretical calculations convoluted with the LOAC electronic noise histogram. We agree that we must discuss more in detail the results of the Lurton et al. paper. On the other hand we don't understand why the referee speaks about “Bragg diffractions”, which refers to crystals.

Figure 4 and page 10004 lines 14-19: Soot particles were presented in the Lurton et al. paper (in fact, they were called “carbon”). A large number of pictures of soot are available in the literature, and they have an irregular shape; most of the soot are fractal (an aggregate of spherules do not produce a spherical large particle). The

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referee comment shows that our text is partly unclear. First, atmospheric particles are rough enough to highly reduce or smooth out the Mie oscillations. Secondly, the LOAC calibration considers the power law that cross the Mie oscillations; thus, there is a unique solution in diameter for a given scattered flux. Thirdly, as said above, we present a new version of the Figure 4 with the offset removed (here Fig. 1), showing that the detected scattered flux is not constant below 0.5 micrometers. Then, we confirm that LOAC can discriminate unambiguously the particle smaller than 10 micrometers. The power law chosen for the calibration curve passes through the firsts Mie oscillation for the smallest sizes.

Page 10004 lines 7-13: Weiss-Wrana observations show that “real” particles exhibit a smooth scattering curve without Mie oscillations.

Page 10004 line 20: We disagree with the comment. The figure shows that the calibration with a power law works well (a calibration problem with a size determination not unambiguously discriminated will not produce such monotonous distribution). But we agree that the figure can be removed.

Page 10004 line 29: We understand the reviewer concerns. Since the submission of the paper, we have conducted new cross-comparison measurements with an SMPS and the FIDAS aerosols counter in a sea spray chamber at different temperatures. The instruments have observed first mainly liquid droplets for temperature above 23° and then salt crystals for lower temperatures. The results confirm that LOAC works well even for liquid particles. We propose to add the figures (here Fig. 2 and Fig. 3, with size distribution comparisons, and integrated concentrations in the 0.2-0.9 micrometers size range) and a new paragraph to discuss these laboratory test results.

2.3 Concentrations measurements

Page 10005 line 23: The Monte-Carlo calculations were conducted for each size class size, not for all size classes simultaneously. Thus there is no assumption on the real size distribution.

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Page 10006 lines 10-14: The curve is obtained by another Monte Carlo approach. Our text is probably unclear, we will try to improve the description of the method.

Page 10010 lines 16-17: We mean that the size distribution of the solid particles sample follows a power law, at least in the size domain observed by LOAC. We agree that this sentence can be confused with the description of the power law used for the calibration.

2.6 Inlet sampling efficiency

Page 10010 lines 27-28. We understand the referee concern. In fact, the “TSI” document refers to tube with a 90° bend. Our sampling inlet at ground is vertical, and we have conducted some tests about the efficiency of our inlets. For balloon flights, the inlet curve can be slightly bended, and the ascent speed of the balloon are taken into account, as explained in the text.

3.1 Concentrations and size distribution

Page 10014 lines 6-9: This figure was obtained for “background conditions”, with a relatively low concentrations of particles. Some discrepancies could be just due to local fluctuations of aerosols content since the instruments were not so close together. The Fog Monitor was calibrated for the detection of liquid particles in fog and cloud; the results in Figures 10 and 11 are just the noise detection of the instrument and are meaningless. The SMPS measures the electric mobility diameter, which can differ from the optical diameter; it is well known that there are no well-established corrective coefficients between these two diameters. Finally, the WELAS counter, which can be sensitive to the nature of the particles, was calibrated for “mean particles”. We think that this cross-comparison is quite confusing and redundant with the other cross-comparisons, including the new one in the sea spray chamber. We can propose to remove the Figures 10-11.

Page 10015 lines 23-25: As said in the text, the calibration for submicronic size was

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done using latex beads, not using sieves. We disagree with the referee comment; the agreement between all the instruments is acceptable or good for particles larger than 0.3 μm . It must be kept in mind that all these instruments have different inlet systems and pumping, and different calibration procedures.

Figure 16: As said before, there is no oscillation in the calibration curve in the 3 – 10 μm size range.

3.2 Tropospheric vertical distribution

Taking into account the errors measurements of the two instruments, LOAC has not really missed one of the important structure detected WALL. The LOAC extinction was calculated using the concentration for particles greater than 0.2 μm . Since the contribution of the smallest particles is missed, the extinction is underestimated in tropospheric background conditions. On the other hand, in the sand plume, the extinction is dominated by the larger particles, thus the agreement is better (showing that LOAC does not miss the large particles).

3.3 Topology of the particles

Figure 18-22: The referee has made an error. The speciation zones were obtained in laboratory with LOAC, with the same size calibration as for measurements in ambient air. Thus an error in size determination cannot produce some points outside the zones. The discrepancies between real measurements and laboratory zones are only due to the heterogeneity of the studied medium.

3.4 Mass concentrations

Page 10021 line 14: The microbalance instruments heat the collected samples, to remove the droplets. If we want to compare the LOAC calculated mass concentrations to the microbalance results, we must remove the contribution of the liquid particles. It is why we have put their density to 0.

Page 10022 lines 28-29: In case of pollution event produced by small particles, as the

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one of December 2013 presented here, at least of 30% of the PM 10 mass and about 50% of the PM 2.5 mass are coming from submicronic particles. Since the contribution of the submicronic particles is not negligible, all counting instruments that are used for ambient air quality monitoring need to start their measurements at 0.2 micrometers or below.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 9993, 2015.

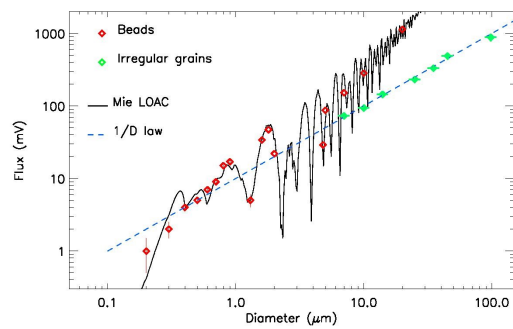


Fig. 1.

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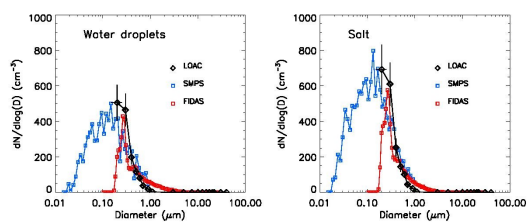


Fig. 2.

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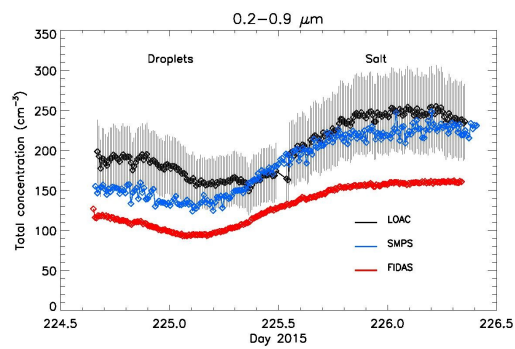


Fig. 3.

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