

Atmos. Chem. Phys. Discuss., referee comment RC3
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Comment on acp-2021-21

Anonymous Referee #2

Referee comment on "Measurement report: Comparison of airborne, in situ measured, lidar-based, and modeled aerosol optical properties in the central European background – identifying sources of deviations" by Sebastian Düsing et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-21-RC3>, 2021

This study compares lidar optical properties to those computed with Mie calculations in function of RH. The topic is important but the work suffers of important lacks in the method section probably biasing the obtained results and related considerations. Thus a deep major revision is required based on the following major issues:

- Lines 290-292: "Also, the residual layer containing some aerosol layer aloft the top of the planetary boundary layer (PBL) between 1250 m and 2300 m is visible indicated by greenish colors." Given the description above and Figure 1 it is clear that ACTOS also sampled in the residual layer between ~1300 and ~2000m. I suggest to correct the sentence at line 292-293 ("The payload, therefore, was sampling in the free troposphere as well as within the planetary boundary layer and was sampling different aerosol populations") and ALL the related discussion and interpretation later in the results.
- Lines 296-297: how much below 40% RH the aerosol was sampled? Consider that aerosol efflorescence (or crystallization) can occur at RH lower than 40%, even below 30% RH in function of the aerosol chemical composition (nitrate to sulfate ratio, degree of acidity, presence of ammonium chloride etc...) (Martin, S. T.: Phase Transitions of Aqueous Atmospheric Particles., Chemical reviews, 100(9), 3403–3454, 2000). Please add a deep discussion based on this point as the manuscript aims at closure in function of RH, but the aforementioned consideration poses an important issues to the capability to reach this goal.
- Lines 306-307, Figure 2 and Lines 316-321: The missing refractive index correction of the OPSS represents a lack of the manuscript in the way as it is actually presented. This section needs an improvement. For example, the inner "detailed geometry of the optical cell inside the instrument" should be asked to the manufacturer (or at least asking the equivalence with that reported in: Heim, M., Mullins, B. J., Umhauer, H., and Kasper, G.: Performance evaluation of three optical particle counters with an efficient "multimodal" calibration method, J. Aerosol Sci., 39, 1019–1031, doi:10.1016/j.jaerosci.2008.07.006, 2008).
- Mie calculation should be biased using the OPSS optical equivalent diameters, thus affecting a part of section 3, discussion and all conclusions. The later (line 326) altitude-

correction factor in eq. 6 does not correct the OPSS optical equivalent aerosol size-bin (i.e. the size of particles) which is, instead, the right parameter needed for proper Mie calculations. It is required to clarify this point for the reader. Moreover, the above approach generate an inconsistency with lines 359-363 ("The OPSS PNSD was corrected in terms of the complex aerosol refractive index. Here, a complex aerosol refractive index of $1.54 + i0$ was used since this resulted in OPSS PNSD with a good overlap to the MPSS PNSD. The imaginary part of the complex aerosol refractive index was forced to 0 because it leads to a significant overestimation of the coarse mode in the PNSD when the imaginary part of the complex aerosol refractive index is above 0 (see Alas et al., 2019). Note, that this complex aerosol refractive index is not the refractive index used in the Mie model") and an inconsistency with lines 368-369 (Particles larger than 800 nm have not been replaced by the PNSD measurements at ground since the refractive index correction was applied to the OPSS data") where different methods were used. I suggest to improve the discussion of the Mie methodology (and related approximations) from line till line 498 to make it clearer and more consistent.

- Lines 350-351: "truncation error of the scattering coefficient was not corrected". Please, add also the uncertainty of scattering and not only that of extinction.
- Lines 360-363: OPSS model 3330 of TSI only accept real part of refractive index. The use of $1.54 + i0$ is mandatory, not a decision. Moreover, this can generate problems if "this complex aerosol refractive index is not the refractive index used in the Mie model" as reported. Please comment and clarify.