Review of “Aerosol optical properties within the atmospheric boundary layer predicted from ground-based observations compared to Raman lidar retrievals during RITA-2021” by Xinya Liu et al, submitted to Atmospheric Chemistry and Physics

I read the reviewer comments and the replies of the authors.

To my opinion the points the reviewers had raised have been addressed adequately well in the revised version. The revised version has undergone (in part) substantial text changes which largely clarify the challenges that come with using ground-based point observations (dry atmospheric conditions in the particle sampling chamber) for the task described in this paper. The use of Raman lidar profiles of backscatter and extinction measured at ambient atmospheric conditions can be considered as the benchmark. The revised version presents a good, critical evaluation of the results and it includes comments on where the methodology presented in this paper stops being useful. I think readers who possess the necessary knowledge in lidar data analysis/ lidar instrument development will gain new insight into the challenging task of using in-situ ground-based observations in two areas of atmospheric observations with lidar and in-situ instruments:

1) How to extend lidar profiles from the first height bin where lidar profiles become useful (full overlap between laser beam and receiver-field-of-view is achieved) to the ground (no lidar data or data affected by an incomplete overlap).
2) How to make better use of data collected with elastic-backscatter lidar, how to use relative humidity profiles and modelling, and how to combine all this information together with in-situ observations in a smart way.

I furthermore consider the use of the SCC as an essential part of the work presented in this manuscript. The use of the SCC understandably means that certain compromises need to be accepted in terms of what type of data are available and how this comparison study can be carried out. I think a good compromise has been found in terms of what needs to be done if “the last bit of information” is squeezed out from the data and the methodology, and what can realistically be achieved (by using SCC in a semi-automated mode). SCC is a key tool of working with lidar in ACTRIS. Yet, even though the authors’ methodology shows reasonable results I encourage them to “squeeze harder” to further improve their methodology.

I also want to emphasize another reviewer’s comment that it is necessary to have more publications on this topic of combining in-situ ground-based data with lidar observations. There are few observation sites that have the necessary hardware and data-analysis experience to carry out such observations in the first place.

My opinion is that the “lidar” profiles (from the modelling) seem to follow too much the relative-humidity profiles, i.e. the modelled lidar profiles may be biased. This point has been raised by one of the reviewers in the first round of reviews. However, I do not see a reason for unwrapping everything at this stage. The replies of the authors to the first round of reviews addresses this point.

For all the above reasons I therefore ask for minor changes/correction:

- I suggest the abstract contains a bit more emphasis on the need of "… a well-mixed PBL including accurate corrections for hygroscopic particle growth" and to emphasize the fact that "… the relative humidity profile may have substantial influence on the shape of the profiles."
- I am asking the authors to become crystal clear on the fact that particle loss effects during sampling of coarse mode particles by the in-situ instruments could become a serious issue if more coarse mode particles are present. Make a respective statement in the conclusion section, please.
- Line 44, the word "of": is it missing in "… spatial distribution aerosol …"?
- Line 72: please consider adding a bit more text to "… the extinction coefficient in the lower atmosphere …", e.g.by adding "… in the region of incomplete overlap between laser beam and receiver field-of-view of the lidar detector system …"
- You need to add a short outline of your paper at the end of the introduction section (section 2 …, section 3, … etc). I think that is (still) a standard part of a scientific publication work.
- Lines 140/141 "… the MPSS electrical mobility diameters were assumed to correspond 140 to volume-equivalent diameter.": can you please insert a reference that corroborates this comment?
- line 186: you need to add the pulse energy to the information on the laser.
- Figure 3: there is a typo in "Tempeture". Please also add (in the figure caption) the meaning of the abbreviations. Please explain (in the legend) the meaning of SIA, EC, SS, MD. Please explain in (3a) CC, RH, GF, PSD, no matter whether it is mentioned in the main body of the text or not. Essential information needs to be given in figure captions, too.
- Line 215: MD? I am curious where mineral dust should come from? Or do you refer to road dust, agricultural dust etc.? I repeat that I do not intend to re-open the review process, but rather consider using backward trajectories in a more extensive way in your future work. 72-hours backward does not tell you a lot. Go for 5-days backward (at minimum). 10 days may be even better. The vertical movement of the trajectories is important, too. It tells you a lot about the possible source of particles.
- Line 280: I think it is nephelometer, not Nephelometer.
- Line 248: number is missing in "approximately … Mm^-1".
- Please check formatting issues like the following: often numbers are followed by the unit "m" without space, sometimes with space. Make it the same.
- Line 413: add "sr" to "… 1.1 sr at 532 nm."
- Line 450: check the reference author name "Moritzet et al. "? Is it "Moritzet" or is it "Moritz et al."? In fact, I do not find any reference with that name in the reference list. In other words: check your reference list for completeness.