Response to Referee #1:

Blue italic font means the authors' answer, standard, black *text symbolizes the reviewer's comments, and* *red italic font* *means manuscript changes, while* black *italic* *font symbolizes the original content of the manuscript.*

Response:

We gratefully thank the anonymous referee for his comments and input. The mentioned points are addressed below.

The article is still poorly written and tedious. Data from various measurements were used in this article including surface instrumentations like D-MPSS, Q-ACSM and lidar system. However, there are only lengthy analysis and few merits. Lidar has its advantage in measuring aerosol vertical hygroscopic growth in ambient environment, which is not evident in this article. In addition, errors due to the different observation methods and uncertainties from optical parameters from lidar should be considered.

We shifted some parts into the supplementary to shorten the lengthy analysis. We updated the scope of the article to highlight some findings. For details on this modification, we refer to the answer to referee #3.

However, the scope of the article is not to show the lidar capability of deriving the aerosol hygroscopic growth (HG), although it would be helpful within this study to simulate the HG of the in-situ measured dry aerosol particles. However, comparing modeled optical parameters based on an HG simulation using lidar HG estimates would be somewhat circular. Nevertheless, the capability of lidar to inspect the hygroscopic behavior of aerosol is included in the introduction:

"Previous studies have focused on the dependence of $\sigma_{ext}(\lambda)$ on ambient RH (Skupin et al., 2013; Zieger et al., 2013). Navas-Guzmán et al. (2019) utilized these effects to investigate the aerosol hygroscopicity with lidar. $LR(\lambda)$ is based on the RH-dependent $\sigma_{bsc}(\lambda)$ and $\sigma_{ext}(\lambda)$, and calculations by Sugimoto et al. (2015) indicated that $LR(\lambda)$ is RH-dependent as well. Ackermann (1998) provided a numerical study based on pre-defined aerosol types with distinct size-distribution shapes to establish a power series to describe the $LR(\lambda)$ as a function of RH. Salemink et al. (1984) found a linear relationship between the $LR(\lambda)$ and the RH. Intensively discussed is the LR-enhancement due to hygroscopic growth in Zhao et al. (2017). They reported a positive relationship between LR and RH, but their study lacks information on vertically resolved aerosol particle number size distributions and other wavelengths. However, their simulations have shown that utilizing RH-dependent LR to retrieve aerosol particle light extinction from elastic backscatter lidar signals results in significantly different values than the constant LR approach."

Uncertainties of the lidar have been specified - 10% measurement uncertainty in terms of backscatter. Extinction estimates by the lidar are derived by LR provided by Mattis et al. (2004) and corresponding uncertainties. We also refer to the answer to referee #3, in which we described the uncertainty of the lidar-based extinction based on Gaussian error propagation.

Errors by the in-situ observations have been tackled utilizing a Monte-Carlo simulation.

Ongoing with the additional report of lidar-based studies investigating hygroscopic behavior of aerosol, we added Zhao et al. (2017) as an additional source for an LR(RH) parameterization and updated Figure 6 with the corresponding curve.
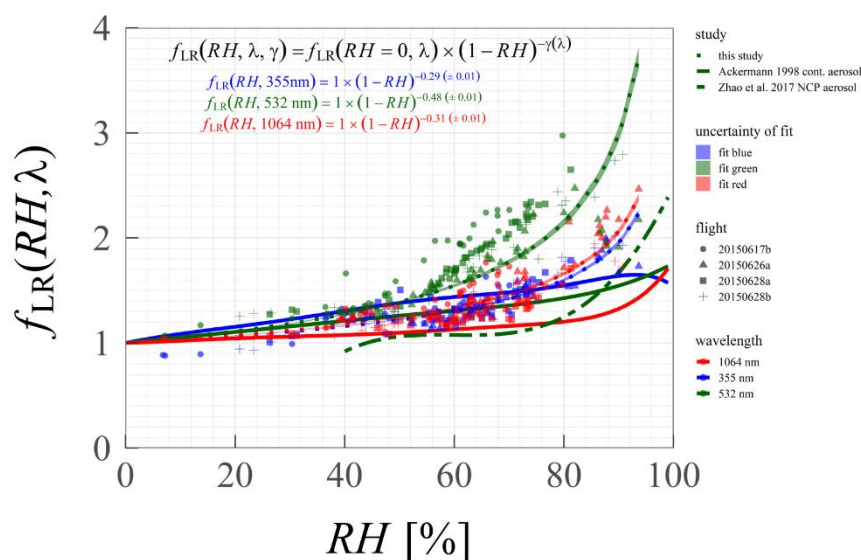

Figure 1: Updated Figure 6.

Zhao, G., Zhao, C., Kuang, Y., Tao, J., Tan, W., Bian, Y., Li, J., and Li, C.: Impact of aerosol hygroscopic growth on retrieving aerosol extinction coefficient profiles from elastic-backscatter lidar signals, Atmos. Chem. Phys., 17, 12133–12143, https://doi.org/10.5194/acp-17-12133-2017, 2017.

The abstract is too long-winded and then innovation is difficult to find. Only one paragraph is suggested for the abstract.

We updated the abstract as requested and refer to the answer to referee #3.

Line 68: replace "does exsits" by "does exsit"

Line 101: replace "were" by "was"

Line 110: replace "is" by "are", Line 112: replace "is" by "are", Line 113: What is "This"?

Due to structural changes in the manuscript these sentences do not exist anymore (see answer to referee #3).

Line 128: delete "is"

We cannot find anything wrong with the sentence: "Melpitz Observatory (51° 31' N, 12° 55' E; 84 m a.s.l.) is located in Eastern Germany in a rural, agriculturally used area 44 km northeast of Leipzig."

Line 230: replace "underestimates" by "underestimate"

Thanks for the suggestion. The sentence in line 294 is now: "However, the bulk Q-ACSM approach might over- or underestimate~~s~~ the hygroscopicity of aerosol particles ~~lower~~smaller or larger than 165 nm in diameter."

Line 290: replace "of" by "for"

We changed accordingly. This part is shifted to the supplementary material.

Line 343: replace "were" by "was"

Since multiple filters were used within the study we changed "filter" to "filters".

Line 535: Poor writing

Thanks for the suggestion. We in the supplementary material lines 63- 65: " *Figure S2b) displays the time series of the number concentration of all aerosol particles up to a size of 800 nm in diameter.*"

Line 578: replace "led" to "lead"

We changed as requested.

Line 618: replace "oppoding to" by "opposed to"

We changed as requested: We changed in line 722 : "~~*Opposing to*~~ *Compared to* … "

Line 702: "solely based on…"

We changed as requested in line 665: "*…above 90% RH which we could not observe in this study* ~~*because of a*~~ *solely based on the small number of cases and the observed RH range.*" ()