

Atmos. Meas. Tech. Discuss., referee comment RC3
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Comment on amt-2021-29

Anonymous Referee #3

Referee comment on "Retrieval of aerosol microphysical properties from atmospheric lidar sounding: an investigation using synthetic measurements and data from the ACEPOL campaign" by William G. K. McLean et al., Atmos. Meas. Tech. Discuss.,
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The authors describe an iterative algorithm for the retrieval of aerosol microphysical properties from atmospheric lidar sounding based on damped Gauss-Newton method including Tikhonov-Phillips regularization. They assume a bimodal-log-normal distribution of a mixture of spheroids and spherical particles. First a simulation study is done. Finally a measurement case is evaluated and compared with the SPEX and RSD retrievals.

The results are interesting, although a few limitations, questions and drawbacks are open.

List of remarks in random order:

- The under-determinedness of the retrieval yields in non-uniqueness. The authors observed the following property:

"A study of the sensitivity of retrievals to the choice of prior and first guess showed that, on average, the retrieval errors increase when the prior deviates too much from the truth value."

This is a well-known phenomenon of iterative methods in case of non-uniqueness. Depending on the initial value the algorithm converges to another "solution".

This is the main drawback of the presented method.

- Question: How many iteration steps were made until the algorithm stops?
- Please, explain all abbreviations.
- "The coarse-mode contribution to the measurements is negligible, thus only the fine-mode microphysical properties are presented". Why? Please, include the values.
- Line 145: I am wondering about the variable n which was not introduced before.
- (8) and (9): I am wondering that MAE is the same as bias?
- "The correlation between the truth and retrieval for both real and imaginary refractive

index components is rather poor, as exemplified by the r values of 0.349 and 0.251, respectively."

This was observed even in retrieval techniques for spherical particles, see Mueller et al, AMT 9 (2016) 5007-5035. The authors should compare their simulation studies with those techniques.

- The pt-font in all Fig. is too small.
- The main results of Tables 3-6 should be summarized, additionally, in a Figure for the conveniences of the readers. The presentation is boring.
- Table 7 caption: The authors should provide more information about: "...what is to be expected from biomass burning, see for example Nicolae et al. (2013)"
- It was interesting to learn that using the presented algorithm one gets:

"However, the difference between the super-lidar and HSRL-2 configuration is not so clear where measurement noise is included, as overall the results are quite similar in that case."

This means in case of measurement errors more input information does not result in a more accurate retrieval. May be this regularization method is not the best one for this retrieval or the regularization parameter was not selected appropriate? Please, regard this point.