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Atmospheric Measurement Techniques
Discussions
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Interactive comment on "GARRLiC and LIRIC: strengths and limitations for the characterization of dust and marine particles along with their mixtures" *by* Alexandra Tsekeri et al.

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The authors provide comparison the inversion of lidar data combined with sun photometer (SP) measurements using GARRLIC and LIRIC algorithms. These algorithms are widely used in the lidar community, so their comparison is important. Moreover inversion of lidar observations collected during CHARADMExp helps to understand better the potential and issues of lidar-SP combining. The manuscript is well written, the authors understand the limitations of their approach and openly discuss it. I think manuscript can be published after minor revisions.

REPLY: We thank the reviewer for his/her kind words!

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Discussion paper

I think in the introduction it would be useful to mention the main (to my opinion) issue of lidar-SP combining. The modal radii of both modes are taken from SP and assumed to be height independent (refractive index as well). Still these values may change with height, for example, due to hygroscopic growth, or due to the presence of layers with different aerosol types. So what will be impact of this height variation to the retrieval?

REPLY: We agree with this comment. We added in the text (pg. 4, lines 18-20): "In case of multi-mode aerosol mixtures and/or change of microphysical properties with height due to particle hygroscopic growth (e.g. Tsekeri et al., 2017) an inherent deficiency of both algorithms is the number of aerosol modes retrieved...". Concerning the impact of this effect, this should be the subject of a different study, which will compare GARRLiC and LIRIC retrievals with height-resolved retrievals. In any case, we already mention in the same paragraph (pg. 4, lines 24-28): "Both algorithms work well for individual aerosol components or mixtures of (mainly) fine (e.g. pollution) and (mainly) coarse (e.g. dust) particles, but they should not be able to fully characterize the mixture components in case of more than one fine or coarse mode in the mixture, as in smoke/pollution or dust/marine mixture cases."

Additional comments

1. Reference "Müller, et al., Atmos. Meas. Tech. Discuss., 8, , 2015". Why AMTD? Wasn't it published?

REPLY: We changed it in Müller et al., 2016.

2. p.11 ln.20 "More specifically, they managed to reproduce this backscatter spectral dependence with imaginary part values of 0.005-0.05 at 355 nm and 0.005 at 532 nm". In the paper Veselovskii et al., 2016, the simulation was performed imaginary part at 355 nm (mI(355)) varying in the range 0.005-0.05, but values of BAE close to experimentally observed were obtained for mI(355) about 0.01.

REPLY: We corrected the text as following (pg. 11, lines 22-24): "More specifically, they managed to reproduce this backscatter spectral dependence with imaginary part values of ∼0.01 at 355 nm and 0.005 at 532 nm."

3. p.11, ln.22 "Although these values are not the same with the retrieved 0.001 at 355 nm and 0.0005 at 532 nm for our case: : :" These values of mI are too low for dust

REPLY: We inserted the following explanation in the following paragraph (pg. 12, lines 2-5): "The same is true for the low values of the imaginary part, due to the mixture of dust with imaginary part of e.g. 0.05 at 532 nm (e.g. Wagner et al., 2012) and marine particles with imaginary part of ∼0.0005 at 532 nm (e.g. Babin et al., 2003)."

4. p.11, ln.23 "The backscatter spectral dependence can be a combination of the effect that different factors have on the backscattered light, as the size, shape or orientation of the dust particles" I think this statement is unclear and unsupported. Yes, size distribution will influence". I am not sure about shape, at least not in the frame of spheroids model. How orientation can influence?

REPLY: We agree that the orientation influence of the backscatter spectral dependence is a speculation that needs to be investigated further. We deleted it form the text.

5. p.11, ln.27. "Differences are seen only for the real part of the refractive index, which for GARRLiC is at âĹij1.45, at the low end of the dust climatological value range of 1.48±0.05-1.56±0.03 as reported in Dubovik et al. (2002)." AERONET can't be used as a reference value for dust refractive index, because it may underestimate the real part. Laboratory and in situ measurements are more reliable.

REPLY: We agree. That's why we continue with the following statement in the text: "This value though is much lower than expected for dust from West Sahara in situ measurements, reporting values of 1.55-1.65 (e.g. Kandler et al., 2007), and it may be due to the marine particle mixture at lower heights, with real part of refractive index of ∼1.35."

6. Fig.5. AERONET shows increase of mI at short wavelengths, which agrees with

known in situ measurements, while mI in GARRLIC doesn't show spectral dependence. Can you comment it? Low values of mI are usually obtained in inversion when high depolarization ratios are considered, because spheroids model can reproduce it only for low mI. Do authors use depolarization ratio in retrievals?

REPLY: The increase shown in mI from AERONET is within the GARRLiC mI retrieval uncertainty. We haven't included the depolarization ratios in the retrievals, since GARRLiC does not use (yet) the depolarization ratio as input for the retrieval.

7. Fig.8. Second row. Misprint. "Garrlic 532" is printed twice

REPLY: We corrected it in the Figure.

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