First of all, we would like to thank the referee for careful reading of the manuscript. His comments helped us to improve the manuscript in the process of revision. Below we provide respond to his comments.

"Main question/comment: In the introduction the authors indicate that the aerosol retrievals that use only the multiwavelength lidar data can have significant uncertainties, especially in the refractive index and single scattering albedo, because the inversion from the 3 backscatter + 2 extinction inversion is underdetermined. They indicate that additional information should be used in the retrievals to improve the accuracy of the retrieved products and indicate that aerosol transport models can be one source of additional information by providing an initial guess for the inversion scheme. While this may be true, wouldn't this then preclude the lidar+model retrieval results from being used to assess the accuracy of the models since the retrieval results would depend to some degree on the model parameters used as input? Perhaps a more pertinent question is how can the model parameterizations, optical properties, aerosol speciation, etc. be improved by the measurements and retrievals described here?"

This is an important question. In this work, we are using the lidar observations to assess the accuracy of the aerosol transport model independently. Our motivation for the work is to show that the aerosol transport model has sufficient skill to serve as additional constraint on the 3 backscatter + 2 extinction inversion. Thus, an inversion of lidar data using GEOS-5 model constraints would probably reduce the uncertainty of the retrievals. The second step will be assimilation of lidar measurements (not retrievals) in the aerosol transport model or even joint processing of lidar and model data. However, this task is very complicated, and we are not ready to move forward with it yet.

1. "Abstract, line 23. How close were measured and modeled extinctions?"

In the manuscript we provide the statistics for the deviation of modeled extinction from observations, but in Abstract we just mention that these are close, because for other episodes the numbers can be different.

2. "Abstract, line 28. What was the simulated lidar ratio?"

It is 40 sr. To make it more clearly we modified the sentence:

"…the simulated lidar ratio (about 40 sr) is lower than measurements (50±7 sr)."

3. Page 3, line 28. Note that the Buchard et al. (2017) validated MERRA-2 extinction profiles with independent airborne HSRL extinction profiles, as well as AOD and PM2.5.

Mentioning of comparison with HSRL is added

4. "Page 4, line 8. Note that Buchard et al. (2017) and Randles et al. (2017) both used airborne HSRL data for model validation."

Mentioning of comparison with HSRL is added.

5. "Page 4, line 26. What wavelength does the Doppler lidar use?"

It is 1543 nm. Added to the text.

6. “Page 5 (line 1). Are these nighttime only Raman lidar measurements? Page 13 mentions Raman lidar measurements of layer AOD so it’s not clear which measurements are nighttime only and which measurements are made both during day and night.”

Continuous night and day time Raman measurements were performed only for selected episodes. In particular, such measurements are available for the smoke episode considered. However in day time, the Raman measurements at 532 nm were possible only up to 2-3 km height.

7. “Page 5 (line 9). Range or height resolution of extinction?”

It is height resolution.

8. “Page 7 (line 28). The blue line is hard to see, but it looks like it also passes over the ocean extensively.”

Yes, the most of the dust is concentrated below 1000 m (red line). At 1500 m (blue line) the concentration of dust is lower (masses are partly transported over the ocean). Corrections are introduced in the text.

9. “Figure 2. What parameter and units are shown in Figure 2? The color bar has no label or units.”

These are arbitrary units. Added to the capture.

10. “Figure 5 does not add much to the paper and can be omitted.”

By this figure we want to show that increase of the wind speed in LLJ is accompanied by increase of backscattering, so LLJ transports the dust. We would prefer to keep this figure.

11. “Figure 10 and discussion on page 10 (lines 21). The dust lidar ratios are 55 and 70 at 532 and 355 nm, respectively. There seems to be a significant wavelength difference in these ratios as compared to previous reports (see for example Müller et al., 2006, JGR) who reported S355/S532 = 1. Any thoughts on this? Figure 12 shows there could be some smoke in this lower layer; perhaps this contributes to a larger wavelength dependence of the lidar ratio?”

Yes, it is important point. In our measurements, backscattering of dust at 355 nm is lower than at 532 nm, though extinctions coincide. We think that the reason is the spectral dependence of the imaginary part of RI of the dust. Observed behavior agrees with simulations, when typical spectral dependence of Im is considered. We aware, that the same tendency is observed in some recent measurements of other groups. But the effect depends on the dust origin. Measurements of Muller et al., 2006 didn’t report the spectral dependence of the lidar ratio, so the dust at SAMUM campaign had probably different origin.

12. “Page 12, line 19. What are the model lidar ratios for these various components? Are these values for the dry contributions of these components and how do these vary at higher RH? (Figure 6c shows RH~70-80% in upper layer).”

Lidar ratios of aerosol components (except dust) depended on the relative humidity (RH). The modeled water vapor profiles are close to the lidar measurements, especially in the elevated layer (fig.17), so the modeled RH profiles are also realistic. The growth factors given in Appendix allow to calculate the size distributions and RI of components for any RH. From these values the lidar ratios are obtained. We didn’t show lidar ratios for separate components, because these are height dependent. The values of modeled lidar ratios of organic carbon at the top of the elevated layer are given in Discussion section (71 sr and 66 sr at 355 and 532 nm respectively).

13. “Figure 16 shows pretty much the same information as figures 14 and 15 so I suggest keeping 16 and removing 14 and 15. “

Yes, we agree. The figures are removed.

14. “Page 15, line 6. If the model represented the depolarization closer to the value measured by the lidar (35% instead of 22%), would the model backscattering profiles at 532 nm be in better agreement with the lidar measurements in the dust layer?”

The model underestimates depolarization because it uses smooth particles (ellipsoids), while real dust particles have sharp faces. It is difficult to say how the presence of sharp faces will influence the backscattering (probably will increase). However, backscattering depends strongly also on the imaginary part of the refractive index. Actually for 355 nm agreement the model and measurements is good. So we think that by fine adjustment of the model parameters (fine particle contribution, mI(532)) better agreement with measurements can be obtained.

15. “Page 15, Inversion section. Just to be clear, the inversions discussed in this section did not use any model information as a first guess, is that correct?”

Yes, no model information is used.

16. “Page 16, line 23. In the dust layer (800-2000 m), the modeled effective radius (blue) seems to agree more with the spherical model (red) overall than the spheroidal model (black). Why? Likewise for volume concentration. This is contrary to what is discussed as a motivation for using the spheroidal model. Likewise for volume concentration.”

There are several reasons for such behavior. First of all, inside the height range 1500-2000 m the depolarization ratio is below 30%, so dust particles are mixed with biomass burning products. Thus the use of only spheroids in retrieval will slightly underestimate the effective radius and volume. Second, we don’t consider spectral dependence of mI in retrieval, which may underestimate the volume and radius up to ~20% (Veselovskii et al., 2016). Actually the volume concentration and effective radius obtained spheres and spheroids differ not so much (keeping in mind that uncertainty of retrieval is ~30%), the reason for this was discussed in (Veselovskii et al., 2010). The use of spheroids is critical for retrieval of the complex refractive index (CRI), because the use of spheres, in particular, strongly underestimates the real part of CRI.

17. “Figure 23. The spheroidal profiles have error bars but the spherical profiles do not. Why? What are the uncertainties in the retrievals that use spherical aerosols?”

Errors bars are the same for spherical particles. We didn’t show these not to overcomplicate the figure.

18. “Figure 24. What are the uncertainties in the lidar retrievals shown in Figure 24?”

Error bars are added.

19. “Figures 23 and 24. The description indicates that the spherical model should be used for the smoke layer and the spheroidal model should be used for the dust layer inversions. What is the criterion (or criteria) for choosing when to use spherical vs. spheroidal? Particulate depolarization? If so, what value of particulate depolarization?”

In principle, the mixture of spheres and spheroids should be considered and the algorithm itself should find the spheroids volume fraction (SVF) for every height. In practices, however, retrieval of SVF at a moment is not stable enough. So we presented retrievals for spheres and spheroids separately. Criterion for the model choice is the particle depolarization. From our experience for depolarization below 15% the spherical particles can be used.

20. “Page 17, line 28. This indicates that this Raman lidar provides profiles of particulate backscattering and extinction with uncertainties below 10%. Are these random uncertainties, systematic uncertainties, or combined uncertainties? Are the sub-10% uncertainties achieved with the 3 minute temporal, 50-125 m vertical resolutions discussed on page 5 or were different resolutions needed to get 10% uncertainties?”

The 10% is the total uncertainty for presented profiles. But to get it at least 30 minutes signal averaging is needed for the vertical resolution specified. The comment is added to the manuscript.