Review of "Characterization of smoke/dust episode over West Africa: comparison of MERRA-2 modeling with multiwavelength Mie-Raman lidar observations" by Veselovskii et al.

Overall this is a good paper that describes a case study of ground-based Raman lidar observations of smoke and dust. The paper describes how these measurements can be used to study these aerosol properties and compares the lidar retrievals of the aerosol properties with those simulated by the MERRA-2 model. The paper shows that overall the modeled aerosol parameters are consistent with those retrieved from the lidar.

The paper is generally easy to follow. I recommend publication after the authors address the points below.

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?

1. Abstract, line 23. How close were measured and modeled extinctions?
2. Abstract, line 28. What was the simulated lidar ratio?
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.
4. Page 4, line 8. Note that Buchard et al. (2017) and Randles et al. (2017) both used airborne HSRL data for model validation.
5. Page 4, line 26. What wavelength does the Doppler lidar use?
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.
7. Page 5 (line 9). Range or height resolution of extinction?
8. Page 7 (line 8). The blue line is hard to see, but it looks like it also passes over the ocean extensively.
9. Figure 2. What parameter and units are shown in Figure 2? The color bar has no label or units.
10. Figure 5 does not add much to the paper and can be omitted.
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 $S_{355}/S_{532} = 1$. 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?

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).
13. Figure 16 shows pretty much the same information as figures 14 and 15 so I suggest keeping 16 and removing 14 and 15.
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?
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?
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.
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?
18. Figure 24. What are the uncertainties in the lidar retrievals shown in Figure 24?
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?
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?