Review of "First triple-wavelength lidar observations of depolarization and extinction-to-backscatter ratios of Saharan dust" by M. Haarig, A. Ansmann, R. Engelmann, H. Baars, D. Althausen, C. Toledano, B. Torres, M. Radenz, and U. Wandinger

reviewed by Mark Vaughan <mark.a.vaughan@nasa.gov>

In this manuscript, the authors use approximately 6 hours of measurements acquired on 22–23 February and 3 March 2021 to characterize the lidar ratios and particulate depolarization ratios retrieved from three wavelength Raman lidar measurements of Saharan dust transported over Leipzig, Germany. They then compare the lidar-derived parameters to the same quantities estimated using the GRASP algorithm and AERONET measurements acquired ~12 hours prior to the February lidar measurements. From these comparisons they conclude that the AERONET/GRASP technique (a) adequately reproduces the spectral dependence of Saharan dust lidar ratios at longer wavelengths (675 nm and above), but fails at shorter wavelengths (440 nm); and (b) deficiencies remain in reproducing the spectral dependence of the particulate depolarization ratio.

This is a well-organized and well written manuscript that I expect will be of particular interest for space-based aerosol lidar applications. Subject to the caveat initially put forward by the content editor (i.e., this manuscript should be published as a "measurement report", not as a research article), the topic is well-suited for publication in ACP. To my mind, the primary contribution of this work lies in providing retrievals of Saharan dust lidar ratios at 1064 nm. The lidar literature abounds with reports of retrievals of dust lidar ratios from across the globe at 355 nm and, to a somewhat lesser extent, at 532 nm. But to my knowledge, BERTHA is unique in being able to deliver high quality *range-resolved* retrievals of 1064 nm lidar ratios. Nevertheless, I have a few quibbles about some of the content that prevent me from fully endorsing the manuscript in its current form. I outline these in a few brief paragraphs below and in an annotated version of the manuscript attached at the end of this review. Once the authors have considered these remarks, I will gladly recommend publication of their paper.

General Remarks

While the manuscript briefly touches on the technique used for the polarimetric calibration (lines 78–80), I find no mention of the method(s) used for the radiometric calibration of the 1064 nm channel (or of any of the other channels, for that matter). The paper should be expanded to include a sentence or two describing the most prominent contributors to the retrieval uncertainties at all three wavelengths. While I understand that "more details can be found in Haarig et al. (2016)" (line 71), the cirrus scenes examined in that paper offer relatively straightforward calibration opportunities, and the dust cases in this paper could be more challenging.

I'm not sure I understand what the authors are showing in panel (f) of Figures 1. They quite clearly state that the 1064 nm depolarization ratio measurements were conducted only during the first 20 minutes of the observation period. So in Figure 1(f), are the 355 nm and 532 nm averaged profiles also restricted to data acquired over the first 20 minutes? If so, the text and caption should both clearly state this fact. And if not, the figure should be recreated using only the first 20 minutes of the 355 nm and 532 nm measurements. Similarly, are the data in the averaged profiles shown in panels (c), (d), and (e) restricted to observations acquired between 22:45 and 01:02 UTC? Again, if they are, please say so unambiguously; and if they are not, please recreate the plots so that all data are from the exact same time period. These comments also apply to panels (c), (d), (e), and (f) in Figure 3.