

***Interactive comment on* “The characterization of Taklamakan dust properties using a multi-wavelength Raman polarization lidar in Kashi, China” by Qiaoyun Hu et al.**

Anonymous Referee #1

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A unique data set of mineral dust optical properties taken in western China close to the Taklamakan desert is presented. The observations were performed with an advanced multiwavelength Raman and polarization lidar. It is probably (almost) impossible for non-Chinese research teams to travel to the westernmost part of China. This makes the data set so valuable.

The paper is well written. I recommend publication after minor revision.

Abstract: Do we need all these details to all 4 discussed cases in the abstract? A few summarizing sentences would be sufficient to my opinion!

Introduction: P2,L26: Please mention the important role of dust particles to serve

as ice-nucleating particles, reference: Kanji, Z. A., Ladino, L. A., Wex, H., Boose, Y., Burkert-Kohn, M., Cziczo, D. J., and Kramer, M.: Chapter 1: Overview of ice nucleating particles, Meteor Monogr., Am. Meteorol. Soc., 58, 1.1-1.33, <https://doi.org/10.1175/amsmonographs-d-16-0006.1>, 2017.

P2, L46: Besides the Hofer 2017 paper there are two additional Hofer papers in 2020. The last of these three articles is on lidar ratios and depolarization ratios measured ‘...a few kilometers upwind...’ of your Kashi lidar station. This paper should be used for comparison regarding the potential impact of long-range transport of dust and pollution advected from Africa and the Middle East.

P4, L92: Basic information about the methods (Fernald, Raman, smoothing lengths, least squares fit, reference height in backscatter determination, input parameters) regarding the computation of the backscatter and extinction coefficients would be fine. The same for the retrieval of the particle depolarization ratio from the volume depolarization ratios. Information on the used temperature and pressure profiles is required. Did you use GDAS profiles? Kashi is a radiosonde station, that means the re-analyzed GDAS data consider these radiosonde observations and are thus perfect to be used in your lidar data analysis.

P4, L116: Improve I... , better write I340 and I380 represent ...

P5, L142: Are you sure that the photometer can correctly measure an AOD of 4.7?

P6, Case 1: The depolarization ratios point to pure dust, and more important, to near-source dust with a large fraction of coarse particles and especially giant particles (radius > 20 microns). This is probably the reason for the strong difference between the lidar ratio at 355 nm of around 60 sr and of 45 sr for 532 nm and the corresponding backscatter wavelength dependence. The Dushanbe observations (Hofer papers) of central Asian, Saharan, and Middle East dust did not show that. Should be discussed.

P6-7: Case 2 is almost ‘no case’, and indicates again the dominance of giant dust

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particles, causing these extremely large particle depolarization ratios of 0.32 at 355 nm and 0.37 at 532 nm. It should be mentioned that the depolarization ratios were exceptionally high because of the presence of very large particles. Burton et al. (ACP) measured very high depolarization ratios at 532 nm close to dust sources, but never at 355 nm. Should be discussed.

P7-8: Case 3: You mention that this is a polluted case, ..and dust was contaminated and coated. Do you have clear indications for that? There is long debate on external or internal mixture of dust and pollution aerosol. Researchers (e.g., Kandler and his team) who investigated Saharan dust particles in the Caribbean did not find any significant coating. They found the same during the SAMUM-2 campaign with strong pollution and dust mixtures. Kandler did not find strong hints on coating and concluded that dust and pollution is mainly externally mixed.

If you do not have clear hints on coating then one should clearly indicate that by writing. ... we hypothesize that dust is coated or so. ...

P8-9: Case 4: This dust case is ideal to compare all the numbers with the findings of Hofer et al. (2020) on lidar and depol ratios.

Discussion: Again, please state clearly that the measurements are taken at a site rather close to a strong dust source so that giant particles have a strong impact on the measurements. This is not the case for almost all the observations published in the literature. After 1000 km travel most giant particles are gone, and the influence of fine dust on the optical properties increases. There is always fine-mode dust and coarse mode dust and giant-mode dust. Fine dust produces depolarization ratio below 20% at 532 and 1064 nm. Not only pollution aerosol can lead to a decrease of the depolarization ratio.

P10, P286: I am a bit surprised that you did not mention the Hofer et al. papers in this context! Should be improved.

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It is good to have Table 3 for comparison and discussion. Please check Hofer 2020 (on lidar ratios and depol ratios) and include it here.

Figure 1: Kashi is at 39.47N and 75.98E, is the lidar field site really at 74.95 E as indicated in Figure 1? By the way, you could even include Dushanbe at 38.53N and 68.77 E in the map.

Figure 3: PM10 does not include the contribution by giant particles. Visibility observations (at the Kashi airport?) would be nice and conversion of the visibility-related extinction coefficients into mass concentrations... That would then clearly show the impact of giant particles.

Figure 6: (a) the height profiles of the extinction coefficients are fine and indicates large particles. But why is the 532 nm backscatter coefficient always larger than the 355 nm backscatter coefficient, even above the dust layer at heights above 4 km? I would assume that giant particles are not present anymore at such large heights, and clearly above the main dust layer. Please check the data analysis.

Figure 11 indicates similar air mass flow at all heights from 1000 to 3000 m.

Figure 10: According to Fig.11 the extinction profiles and the 532 and 1064 nm backscatter and depolarization ratio profiles are fine. But I have always a bit my doubts concerning the 355 nm backscatter and depolarization ratio values. If the particle backscatter profile is a bit wrong in the case of 355 nm then the particle depol. ratio will be wrong as well. The conversion from volume to particle depol ratio is very sensitive to the 355 nm backscatter values.

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