

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2021-1097

Anonymous Referee #2

Referee comment on "Australian wildfire smoke in the stratosphere: the decay phase in 2020/2021 and impact on ozone depletion" by Kevin Ohneiser et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-1097-RC2>, 2022

General comments

The article "Australian wildfire smoke in the stratosphere: the decay phase in 2020/2021 and impact on ozone depletion" by K. Ohneiser et al. presents the long time series of lidar observations of the Australian wildfires 2019-2020 on the transport path of the smoke plumes. The location of the lidar site and the occurrence of this record-breaking wildfire make these observations unique and undoubtedly valuable. These 2-year observations contribute to studies of wildfire smoke particles properties, dynamics and their evolution in the atmosphere. This paper also points out the role of aged wildfire smoke in the depletion of ozone, which requires more scientific investigations. The subject fits well the scope of the journal Atmospheric Chemistry and Physics, the manuscript is very well written and the data are well presented. I would suggest this paper being accepted with minor corrections.

Specific comments:

L79: elastically $i \square$ elastic

L80: 387 and 607 nm include not only nitrogen but also oxygen Raman lines

L106-107: Should give approximate definition about fresh and aged smoke

L133-135: More information about ozone measurements should be given for non-expert, ex. What is the "column ozone deviation" ?

L148-149: "We noticed that ... cross-talk effect in the Raman channel (less than 0.8%)": this sentence is confusing, what cross-talk, Raman signal contaminated by elastic channel.

L231: Did you check AERONET inversions to confirm the strong absorption of Australian smoke?

L284: Please specify the wavelength

L310: what do you mean by "coherent"? should it be 'persistent'?

L356: Kloss2021b-- format of citation

L363: "5-10 higher than"

L375: To be honest, the slight increase of the backscatter-related Angstrom exponent (532-1064) is not visible to me. And if take into account the uncertainty of this parameter, I do not think you can derive a definitive increasing trend.

L393-396: Why not use the simultaneous Angstrom exponent measured by photometer? You are converting columnar AOD to other wavelengths, so it should be converted with columnar Angstrom exponent, isn't it?

L415-419: As the smoke plume intensities decrease with time, the detection becomes more and more difficult, especially for plumes in the UTLS. In the second half year of 2021, mostly extinction coefficients of the plumes are under 2.5 Mm^{-1} and the signal in the cross channel got weaker and weaker because as you said the particle depolarization ratio decreases with time. Under this situation, are the low values of depolarization ratios (close to zero) reliable, how about the uncertainty? In Figure 8c, several data points show slightly negative depolarizations, such as 2020/01/02, 2020/06/25 and 2020-10-28, how come?

L514-522: In my opinion, the contrast of smoke depolarization ratios in Siberian fires and in ANYSO and PNE wildfires cannot be simply explained by the lifting time. The

differences in particles size, absorption..., burning materials...could also contribute and should be mentioned in the text.

L574: citation format: remove the parenthesis (Stone et al., 2021)

L600: PSC not defined

In Figure 4, we see the extinction-related Angstrom exponent is positive (i.e. ext 355 is higher than ext 532), while in Figure 5, it is the reverse, does it mean that particles are getting bigger or it is the uncertainty of measurement? Can you comment?

Figure 1(b, c, d): The coastlines in the maps are difficult to read, please change the color and make them more visible. Explain the label 'CALIOP ANY' in Figure 1e.

Figure 4: What are the criteria for the determination of reliable (solid line) and unreliable (dotted line) extinction coefficient? If the extinction coefficient above 14 km is too noisy to be reliable, so is the lidar ratio.

Figure 5: The same to Figure 5: the criteria of determining trustworthy extinction should be given.

Figure 6: Please specify the wavelength of the extinction coefficient (in Figure a and b) in the caption and in the text.

Figure 8: The intensive parameters are all vertically varying, how was the average performed, daily and vertically averaged? On 26 Jan 2020, the extinction-to-backscatter ratio was < 50 sr, but this data point is not seen in Figure 8b. In addition, the temporal resolution of data in Figure 8a is not the same with those in Figure 8b and 8c, why? Is it due to different quality control strategy?

Figure 13: The legend is missing