Review of:
Vertical structure of biomass burning aerosol transported over the southeast Atlantic Ocean
by: Harshvardhan et al.
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This study examines HSRL2 profiles over the southeast Atlantic and interprets them for insights into aerosol microphysical behavior and transport. This is a valuable objective given the quality of the data, its relevance for satellite data interpretation, and the dominance of smoke above clouds for this region. The work hasn't been carried through as completely as it needs to be for publication, however. Major requests to the authors include the following:

- we need more synoptic context for the days forming the data sample. When was the African Easterly Jet-south active? Did mid-latitude disturbances ever constrain the aerosol to be closer to the coast?
- How do the Lidar profiles correspond with the humidity structure, in particular the extinction? Does this explain the vertical increase in extinction with height? You can use MERRA2 or ERA5 to get the humidity structure, and the Pistone et al. 2021 paper to rationalize the choice.
- the figure panel titles are often difficult to read and should be improved.

Recommendation: accept with major revisions.

More specific comments are shown below, some of which are repetitive of each other and/or the major comments above.

Abstract:
Line 15: Should HSRL ->HSRL-2 ?
Last sentence: it would be worth repeating here that the ‘clear' gap is associated with September.

Introduction:
Line 32-33: It would be nice to find a quote from the most recent IPCC AR6 to replace this one.

Line 41: the recent paper by Kacarab et al., 2020 would serve to underpin this statement. Overall, it would be good to include some updated references. See the ACP special issue.

Lines 56-63: how about also highlighting the ability to discern aerosol-cloud contact? This will affect the reflectance of the underlying cloud surfaces.

Lines 75: the appropriate reference for CLARIFY is Haywood et al., 2021.

Line 85: frame => framework

Lines 92-101: we need more information on why grid boxes A and C were chosen. How much data fell into these boxes and from which days? What distinguishes the synoptics establishing A-B versus C-D? fig. 3 only shows the monthly-mean fields. See Ryoo et al., 2021.

Line 147: I think you just show the effective radius, from this list of possible retrieved variables. Would be good to clarify.

Lines 154-157: yet this list is missing some of the variables you do show….

Line 160: the dates and amount of data from each contributing flight should be provided for each of the boxes. Figure 2 indicates them, but it is qualitative. it might be helpful to show the 2 by 2 degree boxes on fig. 2. Do the northern pairs correspond to when the African easterly jet-south was active? September is also a month when mid-latitude disturbances to the south constrain aerosol to closer to the coast (Ryoo et al., Zhang and Zuidema 2021) and the anomalous ascent can help mix the aerosol (and humidity) upwards - that might explain why the profiles in C-D show the more linear increase in extinction with height. This would also help explain the increase in the depolarization ration below 2km for D .

Line 172-174: interesting, that the northern and southern plumes differ in this fashion. Do you have an idea why? Is the extinction correlated with humidity? You could use the MERRA2 relative humidity profiles to ascertain.

Fig. 2: explain in caption what the letters within the figure mean. Label latitude lines

Figure 3: use the same spatial domain for the top and bottom figures. What do hysplit back trajectories at 2.5 km look like? Do those also connect to land? I ask because the back trajectory duration is so much longer for those in fig 4. This would also help explain if it is marine or continental air with different aerosol properties getting incorporated into the retrievals. Would a case study be helpful?

Fig. 5: It would be helpful to put these time ranges in synoptic context. Visit Ryoo et al., 2021.

What was the relative humidity and how does it affect these results?

Fig. 7: it should be possible to discriminate whether the enhanced depolarization below 2km is from marine air mixed upwards (this is my hunch) from continental air. Just looking at some example profiles and examining the air flow - perhaps the information in Ryoo et al., 2021 and Redemann et al., 2021 on the individual flights is enough.

Figs 5-10: the titles on all of these panels are difficult to read.

References:

J.-M. Ryoo, et al., 2021: A meteorological overview of the ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) campaign over the southeast Atlantic during 2016-2018. Part 1 - Climatology *Atmos. Chem. Phys.*, **21**, 16689-16707, doi:10.5194/acp-21-16689-2021

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Kacarab, M., et al. 2020: Biomass Burning Aerosol as a Modulator of Droplet Number in the Southeast Atlantic Region. *Atmos. Chem. Phys.*, **20**, p. 3029-3040, doi:10.5194/acp-20-3029-2020

Haywood et al., 2021: Overview: The CLoud-Aerosol-Radiation Interaction and Forcing: Year-2017 (CLARIFY-2017) measurement campaign, *Atmos. Chem. Phys.*, **21**, p. 1049-1084, doi:10.5194/acp-21-1049-2021