

Atmos. Chem. Phys. Discuss., referee comment RC1
<https://doi.org/10.5194/acp-2021-759-RC1>, 2021
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Comment on acp-2021-759

Anonymous Referee #2

Referee comment on "Biomass burning events measured by lidars in EARLINET – Part 2: Optical properties investigation" by Mariana Adam et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-759-RC1>, 2021

This is a follow-on study from Adam et al (2020), using the results of that analysis to examine the properties and origins of smoke layers detected by the EARLINET network. The enormous amount of data collected by EARLINET and the careful analysis presented in the first paper provides the opportunity for some meaningful statistics, which are very much needed as we become ever more aware of forest fires in our warming world. However, the paper requires major revision before being suitable for publication.

- The greatest weakness in the presentation of the paper lies in the Introduction, where we learn almost nothing about the results of previous studies of smoke transport – simply providing a long list of references is not sufficient to set the context. What have other authors found? What is the gap in their results that this paper is going to fill? A more thorough Introduction needs to prepare the reader for the methodology and approach that this paper uses. As it is, the paper just presents statistics with no context. A cursory 'literature survey' pops up in the results section (Section 4 page 6 lines 5-14), but this is not the right place nor it is anywhere near comprehensive enough.
- Also required is a clear description of what the lidars measure and how the intensive variables inform us about aerosol properties. Towards the end of the paper, for example, lidar ratio is explicitly referred to as 'absorption', but nowhere in the paper is there an explanation of why the authors make this connection (nor even clear references to that effect). On p.7 l.26-9 the paper simply states that this is so with no explanation. It would be better to provide a clear explanation in the Methods section of what the intensive variables tell us – that would then justify why they are used. There is discussion on p.4 of fresh and aged smoke which could be extended for this purpose. Bear in mind that there will be readers of this paper who are not intimately familiar with Raman lidars.
- The greatest flaw in the methodology of this paper is the use of single 10-day back-trajectories to infer the origin of the smoke layers measured. This is such a severe limitation that it could even be taken as grounds to reject the paper. Nowhere is there a discussion of the huge uncertainties in back-trajectories, or of the need for clusters of them to decide whether the flow is sufficiently non-dispersive to make them valid. Over 10 days in the troposphere most trajectories will be highly dispersive. This means that

attributing source regions to the measurements is fraught with error. In addition, as the authors do recognise but do nothing about, the passage of a trajectory 9 km above a fire only implies a causal link if the fire plumes extended to 9 km, which in most cases they don't. I realise that this may well be an intractable problem, and that the results of this study may be novel enough to publish anyway, but the paper must discuss how the uncertainty in their source apportionment methodology affects the conclusions they draw. (Crudely, it makes any attempt to draw a distinction between different source regions null and void).

- Section 3.1 lines 20 - 30. A number of features in fig.1 are discussed here but it is not possible to relate them to the figure as that is organised by layer number not date (and for the first point discussed not even a date is given). Please point out exactly where in fig 1 the discussion is addressing in each case.
- Section 3.1 lines 31 - p.6 l.3. The text here needs to be more quantitative and again refer exactly to the supporting evidence in fig.1. Terms like 'moderate', 'high' and 'low' are out of place here because the reader doesn't know the context within which these comparators sit. Furthermore, is there enough evidence to support sweeping generalisations like that on absorption, based on what looks like one event? The section also requires proper referencing to support the interpretations being presented.
- The authors should carefully consider moving Fig 7 to the Supplement and removing the final paragraph of 4.2.1 which is descriptive and offers no interpretation of any value.

Typos and minor corrections (of which there are many more than listed here)

p.2 l.21 'indicate that climate change'

p.2 l.30 EARLINET provides remote-sensing lidar measurements not ground-based measurements. The lidars are on the ground but the measurements are not.

p.3 l.6 origins

p.3 l.8 'This paper presents Part 2 of the investigationEARLINET, focussing on interpreting the results'

p.3 l.20 'averages over 1 h'

p.3 l.22 'presence of smoke layers'

p.3 l.22-3 '.....stations, typically by means of.....'

p.3 l.28 'described in detail in Part 1'

p.4 l.6 'middle points of a 1 km grid'

p.4 l.12 'criterion is presented in Table 2'

p.4 l.13. Why do you explain BAE and PDR but not the other acronyms here? Either define all of them or just refer the reader to Appendix A.

p.4 l.25 'which allowed the degree of oxidation in BB aerosol to be estimated'

p.5 l.14 and fig 1 caption 'layer altitudes'

p.5 l.16 and fig 1 caption 'the literature'

Fig 1 caption last line 'panel titles'

p.5 l.27 '....reported in the literature, but still within....'

p.5 l.30 delete 'the'

p.6 l.5 'with' instead of 'by'

p.6 l.6 'discuss stratospheric'

p.6 l.7 you can't have a single event lasting six months. What exactly did Baars et al do?

p.6 l.9 you abruptly transition from previous studies to results from this study with no explanation. You need to explain to the reader that you are now presenting your own results.

p.6 l.16. Replace the sentence 'For a straightforward comparison, we reproduce the figure for the South-East region from Part 1' by '(Note that the figures for the south-east region are the same as Figure 11 in Part 1)'

p.6 l.18 delete 'a number of'

p.6 l.27 'Eastern Europe', also delete 'region'

p.6 l.30 replace 'contained a' with 'observed', and omit 'the' before Cabauw.

p.7 l.2, 4 and 6 'Eastern Europe', also 'Southern' on l.6

p.7 l.8 'Events where small particles are transported in the boundary layer from these regions to North-West Europe.....'

p.7 l.11 Arctic (not arctic)

p.7 l.23 'results for the South-East region'

p.7 l.26-29 – this paragraph is out of place and should form part of an expanded Introduction or be included in the methodology section when lidar ratio is introduced. There should be more references to the link between absorption and lidar ratio as well.

p.8 l.2 'LR@355 being larger...' (the verb in this sentence is 'indicates'). 'From the EU region' on l.3

p.8 l.9 'the supplement'

p.8 l.15 'which are larger'

p.8 l.17 'between the NA and EUNA....', then 'the EUNA' on the next line

p.8 l.22 'the South-West'

p.8 l.23 'the EU and AF'

p.8 l.24 'indicate a large'

p.8 l.25 'Similar, large, values ... for the NA....'

p.8 l.26 'the EUAF'

p.8 l.27 'the AF'

p.8 l.28 'the North-East'

p.8 l.31 'the EU'

p.9 l.1 'the EUAF'

p.9 l.4 'the EU' and 'the NA'

p.9 l.7 Replace 'We perform the analysis based on the mean IP values as a function of continental source region. We consider analysing the scatter plots between the different CRs and EAE, where, for each scatter plot, the mean values correspond to the same measurements. Still, different scatter plots can refer to slightly different sets of measurements.' With 'We present analyses of mean IP values as a function of continental source region by means of scatter plots between the different CRs and EAE'. I didn't understand what you meant by 'for each scatter plot, the mean values correspond to the same measurements.'

Fig 6 – why are there two 'literature means' on panels a-c and several on panels d-f?

p.9 l.23 'except for'. Also the lowest EAE is <0 , not <0.5 . The sentence degenerates into confusion. $CR_{PDR} < 1$ means (not indicates) that $PDR_{355} > PDR_{532}$ as that is how it is defined. It may indicate aged particles except that the next clause (l.24) contradicts this and says that PDR_{532} can be greater for either fresh or aged smoke. (This is why a clear literature survey earlier in the paper is so important). What are you trying to say?

p.9 l.24 Datasets cannot be statistically significant – what correlation exactly does this refer to?

p.9 l.25-6 'From fig 6a, a slight....'

p.10 l.9 'the EU'

p.10 l.11 'a result'

p.10 l.12 'the EUNA', 'the EUAS'

p.10 l.32 'the NA'

p.10 l.33 'the EUNA'

p.11 l.1 'the local (EU) contribution determines whether ...'

p.11 l.3 'the EU' 'particle size'

p.11 l. 5 'the EUAF the EU'

p.11 l.13 'the EUAF'

p.12 l.10 and 11 ') 'after America.

p.12 l.13 'The analysis..' – the sentence does not make sense and needs redrafting

p.12 l.15 change 'helping identifying the smoke' to 'helps to identify smoke'

p.12 l. 30 'measurement regions'

p.13 l.2 'the ACTRIS'

p.13 l.3 'applied to'

p.13 l.4 'providing more ... datasets' or 'providing a more dataset'

p.13 l.8. Remove double .. 'shows the potential of the approach described'

p.13 l.10 'results obtained' not 'obtained results'

p.13 l.13 remove the sentence 'This extension...' It is superfluous and also flawed grammatically