

## Response to Reviewer Report #1 by Janicka & Stachlewska on 14 May 2019

Dear Referee, Dear Editor,

We are grateful to Referee for comments and suggestions that allowed us to improve this manuscript. In the following, the answers to Referee's comments and issues raised are reported directly below each related comment (in bold). All modifications of the initial version of the manuscript as well as additions are reported in color highlight in the revised version of the manuscript. We believe that we have fulfilled required changes in the final version of the manuscript.

The paper by Janicka and Stachlewska discusses the optical properties of biomass burning aerosol during a heat wave event over Warsaw. The study employs a multi-wavelength Raman lidar and model simulations to identify and characterize the different biomass burning layers. The results constitute an interesting database of biomass burning particles as well as mixtures over Eastern Europe.

**Thank you. We appreciate that you value the dataset presented in our study, which was evaluated manually to create a specific data base that allows to assess the representativeness of each result.**

In many parts, the paper is worded poorly and some important aspects are not fully covered, hence there is lack of clarity in the presentation. I suggest that the English must be improved. I have several technical comments addressing this. The paper is not yet suitable for publication in ACP unless some major issues are addressed.

**Thank you for your comment. Of course we are not native speakers and it is our mistake, not sent manuscript for professional English editing before the first submission of the manuscript. Language proof will be done by the professional English proofreading service before submission revised version. We realize that this was one of the reasons due to which important aspects were not well described.**

**One of them is that the aim of this paper was never set on aerosol typing. There was never a procedure for aerosol typing introduced nor aerosol mask was applied. What we did was a rather classical layer interpretation approach done for every single layer separately. It was done in a manual way and interpreted based on the backward trajectory simulations, the satellite data and the literature review.**

**The second aspect is the microphysical inversion, which as performed on the dataset discussed in this paper (part I) will be the subject of the 'part II' manuscript. We truly regret that this information was not clearly stated in the text, which was confusing to the reader.**

Firstly, important and minor revisions are given for consideration in Major and Minor Specific Comments. Secondly, I tried to give Technical Comments although it was impossible to include all of them. Pg1Ln1 means line 1 of page 1.

**Thank you very much for such many and detailed comments. Below we are addressing them point by point.**

### **Major Specific Comments**

Pg1Ln11: What is a sub-layer? I think in the abstract this term is confusing.

**Indeed, we agree. In the abstract the term 'sub-layer' is changed to 'layer'.**

§3: It would be nice to see some discussion on how you retrieve the ‘sub-layer’ along with an example.

**Thank you for the comment. We add in the text of Methodology Pg5Ln21 following clarification:**

**‘The definition of the sub-layer in this paper is not standard as it is not based on the typically used gradient of the signal. The sub-layers were discriminated to fulfill the quality requirements to further microphysical retrieval (part II paper). The sub-layer selection is appropriate for such inversion if the extensive optical properties ( $\alpha$ ,  $\beta$ ) follow the same tendency at each wavelength (i.e. constant, increasing or decreasing).**

**In the sub-layer discrimination, the first step was to select the constant sections in the relative humidity profile and compare them with the extinction coefficient profiles. In the next step, the correspond to the backscatter coefficients profiles as well as to the sub-layers visible in the depolarization ratio were checked and corrected if necessarily. Examples of how the sub-layers were selected are shown on the profiles in Fig. 5 and in the Appendix A.**

**Finally, the sub-layers were collected into groups (layers) characterized by similar properties and described in the statistical way by the mean values of the intensive optical properties and the relative humidity with the standard deviation. The layers were discriminated based on the relative humidity and depolarization plots, as the differences between the layers were the most pronounced using these properties. Then, the first choice was revised with the spread between the properties using the plots of mutual relations of intensive optical properties and relative humidity shown in Appendix B. If particular layer had too much noise (especially upper layers) it was no further analyzed.’**

Similarly, you should discuss in detail the aerosol typing process. It is not clear to me what information you use to make your aerosol mask.

**Thank you, it was misleading in the text.**

**The aim of this paper was never set on aerosol typing. There was never a procedure for aerosol typing introduced nor aerosol mask was applied. Therefore, the data showed in Table 1 are interpretational results based on the backward trajectories simulation and satellite data.**

I think, also, that in the last paragraph of this section you can add a summarizing table with the available measurements and the averaging time.

**We are not sure that we correctly understood the comment. The time averaging for each set of profiles (available measurements) is explicitly given in Appendix A on each plot. Moreover, explanation of used averaging times is given in section Methodology in Pg4Ln27 to Pg5Ln3. We fell there is no need to repeat this information in an extra table. Unless, we did not understood this comment of the Reviewer.**

Pg5Ln23: If I understand well, you identified the layers using the particle extinction coefficient and RH data. Can you discuss more on this method? You can give an example.

**It has been answered above.**

Pg5Ln26: For the identification of the layer boundaries, which extensive parameter are you using? Is this parameter at full resolution? Does the smoothing affect this decision? I am asking all these because the minimum layer thickness is 89 m.

**For all profiles initial smoothing with running mean of 112.5 m was applied only on the raw signals (Pg5Ln10-11). The extinction coefficient profiles were additionally smoothed as given in section Methodology Pg5Ln16-20. Sub-layers boundaries are, at first, obtained on relative humidity and extinction coefficient profiles. Then, the choice was revised with the backscatter coefficient profiles (no additional smoothing).**

**Moreover, as the sub-layer choice was done to come up within the layers with coherent properties (useful for microphysical inversion) we were not looking at the gradient but for the coherent parts of the profiles, thus the effect of the smoothing is negligible even for this very thin layers.**

Pg5Ln27-30: Why do you use mean backscatter and extinction coefficient values In order to estimate the intensive parameters? To my knowledge, the profiles of the intensive parameters, which are type dependent, indicate layer homogeneity etc. Therefore, the intensive properties profiles will serve the purpose of your study.

**The procedures used for aerosol typing are based on the intensive properties profiles but here we defined the layers based on the extensive optical properties as being useful for the microphysical retrieval. The intensive properties were calculated for inspection of the results in already defined layers. It is also the reason that in the plots in the Appendix A the intensive properties are shown as the mean values not the profiles.**

Pg6Ln28: Why do you use reanalysis and GDAS? I think that reanalysis data perform better and should be preferred.

**Please note, that in this paper for interpretation we used only the simulation with the reanalysis data. The simulation with the GDAS model was shown only to stress that for the chosen cases it resembled the results obtained with reanalysis in surprisingly good manner. Therefore, we agree to remove the HYSPLIT trajectories modeled with GDAS data, which shall also reduce this already lengthy paper. Thank you.**

Pg7Ln16: Where does the statement ‘look less reliable’ come from? Expand please.

**As suggested, the analysis of trajectories with GDAS model is excluded (Pg7Ln13-19 and Pg7Ln26-3).**

§4.2: I recommend to remove section 4.2 and the description of the event with backward trajectory analysis moved to section 4.1. The comparison of reanalysis and GDAS falls out of the scope of this study and the findings do not support the preference for one dataset over the other.

**As recommended, the analysis of trajectories with GDAS model is excluded. Then the paragraph 4.1 and 4.2 are combined under name ‘Meteorological situation and air-mass transport’.**

§4.3: Is the layer characterization assisted with the backward trajectory simulations? If this is the case, the way you classify biomass burning aerosol should be part of the methodology (I think I made this comment already).

**Thank you for the comment. In section Methodology following clarification has been added (Pg5Ln31): ‘The interpretation of the layers shown in Fig. 6 was based on the HYSPLIT backward trajectory simulations performed using the reanalysis meteorological data (Fig. 3), the inspection of the MODIS fire data (Fig. 4) and the literature review. The biomass burning aerosol was classified as follow: semi fresh (up to 2 days of transport), moderately fresh (2-3 days of transport), moderately aged (3-4 days of transport), aged (5-6 days of transport).’**

Could you specify the time window you used in order to characterize the BBA layers as fresh, moderately fresh, etc. I presume that this information is incorporated from the model simulations, therefore I insist that this description should be part of the methodology.

**Yes you, are right. It has been clarified as above.**

§5: I did not find connection with other studies on the topic. You could create a summarizing table with your findings and the findings from other studies. I think this point is important.

**We reckon that it is a valid point, however there is several publications that presents nice comparison tables for values ranges reported in literature (e.g. Baars et al., 2016, Papagiannopoulos et al., 2018, Nicolae et al., 2018). A very recent, excellent table is presented by Nicolae, et al.: A neural network aerosol typing algorithm based on lidar data, Atmos. Chem. Phys., 18, 14511-14537, 2018.**

**This is why we did not see the necessity to repeat such table in our paper (especially as both papers are in the same issue). In revised version we reference to this table. Moreover, we checked obtained in our paper results against the values reported by Nicolae et al. (2018).**

**In our case, lidar ratio for biomass burning particles only in a very few values goes beyond the range listed in Table of Nicolae et al. For pollution, we observed slightly lower lidar ratio values than reported in this Table. Our particle depolarization ratios (below 5%) is within the range reported for biomass burning aerosol and pollution in this Table. Also our extinction-related Angstrom exponent for both aerosol types is similar and only for a few cases slightly higher than reported in this Table.**

Pg8Ln30: 'The sub-layers... $\alpha$  profiles'. Will you explain how this selection is made?

**Thank you, this is now elaborated in Methodology as answered above (In Pg8Ln30 this sentence is removed).**

Pg9Ln8-10: The assumption of dust particles over Warsaw for this specific case is farfetched when taking into account the simulated trajectories. The depolarization ratio value of 8% is rather too low. Does this come from a 'sub-layer' (Fig. 5a)? What do the other intensive properties show?

**Thank you, we revised this sentence as following: 'Above the height of 4 km in Fig. 5 (a) weak layer with depolarization ratio of  $\delta_{\text{par}532} \sim 8\%$  (the West coast of Africa pointed by the trajectories at 4 km; not shown for clarity of the figure). However, this layer is no further analyzed due to high noise in the profiles.'**

Pg9Ln15: What does this anti-correlation mean? Is it due to dust contamination? Checking Wiegner et al. (2011) there is no such thing observed.

**We would like to address this issue. In the paper Wiegner et al.: The May/June 2008 Saharan dust event over Munich: Intensive aerosol parameters from lidar measurements, J. Geophys. Res., 116, D23213, 2011; there is no backscattering profiles shown. Therefore we cannot agree with Referee that anticorrelation was not observed by Wiegner et al. (2011).**

**Unless, there is another paper Wiegner et al. (2011)?**

**Moreover, in the text we removed the sentence of dust contamination (Pg9Ln16-18) and added more explanation and rephrased Pg13Ln1-4.**

**Interpretation of anticorrelation of  $\delta$  and  $\beta$  was reported in our study (mixed biomass burning and pollution), as well as Chazette et al. (2017) (polluted continental, biomass burning) and Haarig et al. (2017) (marine aerosol) can be attributed to particle size (sphericity) increase with water uptake.**

Pg9Ln25-31: Could you expand on the technique for the aerosol typing? Is this technique based only on RH and  $\delta$ ? Are these two parameters sufficient? However, In lines 27-28 you refer to intensive properties, do you use them for the typing? If yes, do you use lookup tables or other information? Furthermore, the different colours refer to different layer aging, is this information solely based on intensive properties or do you use Hysplit info? I am a bit confused. Please clarify.

**Sorry for the confusion. The current paper was never meant to be used in a sense of aerosol typing nor lookup tables. Instead we performed aerosol layer interpretation. The approach is**

now better described in the Methodology section (full chain of steps, which are far beyond RH and delta analysis). The different colors denote layers, which differ with particular aerosol property and not precisely with the age. However, for different ages we obtained different properties.

Pg10Ln23-25: I would expect that pollen is depolarizing, whereas in your measurements I do not observe depolarizing layers. Can you comment? Moreover, the event presented by Sicard et al. (2016) is during the pollination period (i.e., Spring). Could pollen be observed in August? Can you support this statement?

Thank you for this questions. First of all the peak for the (widely understood) pollen measurements (pollen plant and fungi spores) in Warsaw, it is observed during daytime (4-18 UTC), as it is strictly confined to development of daytime boundary layer. The pollination periods depend on pollinating species. For some of them it can start in early spring (e.g. birch) and last till late autumn (e.g. nettle). Of course not all pollen particles are aspherical (e.g. utrica), but fungi spores are elongated and can produce depolarization signature. Thus, observations of pollen in August is not unusual over Warsaw. Depolarization values between 8-12 % at 532 are characteristic for cladosporium dominant in summer. Note that the lack of strong depolarization due to pollen at nighttime is expected.

Currently we have a publication on this topic in review; we will add the reference in the revised version. However, if the reviewer finds it important, we can elaborate more on this in the text of the current paper.

Pg10Ln27: What does this ratio show? Please, describe. How is this ratio connected to pollen?

Thank you we revise the sentence as follows: ‘the ratio of  $\delta_{355}/\delta_{532}$  ( $CR_{\delta}$ ) was calculated to emphasise spectral dependence of depolarization between the layers (the lower  $CR_{\delta}$  the more pollen contamination)’.

For pollen particles we expect small values of the  $CR_{\delta}$  (values around 0.35, this study) as the depolarization at 355 nm in the case of very large size ( $>10\mu\text{m}$ ) aspherical pollen/fungi particles is expected to be low. On the other hand, the  $CR_{\delta}$  above 1 will indicate likely existence of small size depolarizing particles (eg. Haarig et al. (2018), this issue).

Pg11Ln7: Give literature values for fresh BBA and link it with your findings.

Thank you, references are added (Nicolae et al. (2013), Baars et al.: Aerosol profiling with lidar in the Amazon Basin during the wet and dry season, J. Geophys. Res., 117, D21201, 2012.).

Pg11Ln17: Give literature values for aged BBA and link it with your findings.

Thank you, references are added (Ortiz-Amezcuca et al. (2016), Ritter et al. (2018)).

Pg11Ln17: Give more information on the CRLR threshold.

Following clarification has been added into sentence (Pg11Ln17): ‘The threshold of  $CR_{LR}>1$ , which is indicative for aged BBA, so as referring to the reported in the literature relation of values of lidar ratio being higher at 532 nm than at 355 nm (e.g. Nicolae et al., 2013, Ortiz et al., 2016), was obtained only in five sub-layers.’.

Pg12Ln23: In Fig. 7c, where is the aging effect in the scatter plot?

Please note, that in Pg12Ln23 we cite the results of Samaras et al. (2015), not our results. The following sentence has been added to clarify: ‘In fig 7 (c) the ageing effect of BBA is marked by the layer color (semi fresh in pink and red, moderately fresh in blue and aged in orange). This



	60 ± 12	67 ± 7	82 ± 8	1.1 ± 0.4	2.5 ± 0.7	0.60 ± 0.32	0.89 ± 0.34	0.68 ± 0.12	1.13 ± 0.14
<b>10/11 August 2015</b>									
<b>L1(b) H (1 – 1.3 km); T (21 – 02 UTC)</b> <b>pollution dry</b>									
	53 ± 5	31 ± 4	55 ± 1	1.6 ± 0.1	3.8 ± 0.2	2.03 ± 0.21	0.69 ± 0.13	0.36 ± 0.04	0.58 ± 0.06
<b>L2(b) H (1 – 1.3 km); T (19 – 21 UTC)</b> <b>pollution dry + pollen</b>									
	73 ± 12	45 ± 11	58 ± 2	1.8 ± 0.1	4.8 ± 0.3	1.82 ± 0.37	0.56 ± 0.10	0.26 ± 0.05	0.60 ± 0.07
<b>L3(b) H (1.3 – 1.5 km); T (19 – 00 UTC)</b> <b>BBA semi fresh (up to 2 days) higher lidar ratio, less depolarizing</b>									
	114 ± 33	78 ± 25	48 ± 4	1.6 ± 0.3	3.8 ± 0.5	1.50 ± 0.19	0.58 ± 0.24	0.44 ± 0.03	0.69 ± 0.07
<b>L4(b) H (1.5 – 1.7 km); T (21 – 00 UTC)</b> <b>BBA moderately fresh (2-3 days) less depolarizing</b>									
	80 ± 7	66 ± 9	64 ± 2	1.1 ± 0.1	2.8 ± 0.1	1.41 ± 0.12	0.90 ± 0.18	0.39 ± 0.05	0.82 ± 0.09
<b>L5(b) H (1.5 – 2.0 km); T (19 – 02 UTC)</b> <b>BBA moderately aged (3-4 days) more dry</b>									
	69 ± 9	61 ± 7	76 ± 4	1.0 ± 0.1	2.3 ± 0.3	1.30 ± 0.15	0.99 ± 0.10	0.47 ± 0.06	0.88 ± 0.05

Pg1Ln15: You mention fresh, moderately fresh, and moderately aged. In Table 1, you also refer to aged BBA. Why not include it in this sentence?

**Sorry for being not clear. In fact we talked about the aged BBA in lines 15-18, but the composition of the text was, indeed, confusing. It is revised now.**

Pg1Ln15-17: Why do you refer to this specific layer in the abstract?

**It is an interesting aged BBA layer you just asked for before. We revised the abstract and now we are referring mainly to the most different layers (polluted, semi fresh bb and aged bb).**

Pg4Ln11: Do the data shown in this study follow the QA and QC procedures of EARLINET?

**Yes. We added respective sentences.**

Pg8Ln14: Do you have any literature reference to support this claim?

**Well, we have several press release reports regarding local fires, which were not seen on the MODIS data. We did not make links to press news as it is in Polish language only, e.g. [https://www.lublin112.pl/kolejne-pozary-pol-lasow-radawcu-gaszenia-wezwano-samolot-zdjecia/#close\\_info\\_content](https://www.lublin112.pl/kolejne-pozary-pol-lasow-radawcu-gaszenia-wezwano-samolot-zdjecia/#close_info_content)**

Pg8Ln31: Give more information for the PolandAOD database.

**The Polish Aerosol Research Network (PolandAOD) conducts the measurements of aerosol properties and radiation budget in several cities in Poland (supplementary materials of Markowicz et al. 2016: Study of aerosol optical properties during long-range transport of biomass burning from Canada to Central Europe in July 2013, Journal of Aerosol Science, 101, 156-173, 2016). We added this reference. More information on the PolandAOD Data Base is available via the website <http://polandaod.pl/>. Corresponding information is added in the text.**

Pg9Ln19-24: Aren't the lidar signals too noisy to make any deductions? I would omit this discussion.

**We would like to keep this description, as it is not unusual to see at Warsaw such intrusions of arctic air. The long term study analysis even within boundary layer indicates that at least 5% of the long range intrusion had arctic marine origin (Wang et al., 2018, this issue). Therefore it is even more likely to see an arctic air at higher altitudes.**

Pg10Ln24: You mention high values of depolarization ratio, whilst 4.8% is definitely a small value. Please clarify.

**Sorry for being unclear. Of course 4.8% is relatively low depolarization. We rephrased Pg10Ln24-25 to: ‘For polluted layer in Warsaw we expect values of  $\delta_{\text{par}532}$  below 1% (Wang et al., 2018), thus the relatively high value of 4.8 % (which is decreasing during the night, along with a slight increase of  $\text{ÅE}_{355/532}$ ) can reflect contamination of this polluted layer with a pollen particles waning after the sunset.’**

Pg11Ln5-7: What did the model simulations show?

**We assume Referee means the HYSPLIT model backward trajectory simulations. If yes, we add in the text following sentence: ‘The HYSPLIT backward trajectory simulation indicate, that at the altitude of ~2 km on 9/10 August, more likely semi fresh biomass burning aerosol (up to 2 days old) was advected from over German and the Czech Republic.’**

Pg11Ln11: I think the statement ‘small depolarizing particles’ is untrue. Please rephrase.

**Sorry for being unclear. We rephrase the sentence Pg11Ln8-12 as follows: ‘The  $\text{CR}_\delta$  value for this layer was the highest (~0.49), in comparison with all other layers.’.**

Pg13Ln20: Can you quantify ‘partly consistent’?

**Thank you for the comment. We rephrased the fragment Pg13Ln20-23 as follows: ‘Results of MFR-7 Shadowband Radiometer (PolandAOD-NET, <http://polandaod.pl/>) are consistent in terms of higher AOD derived at shorter wavelength with the data of C318 Sun Photometer (AERONET, <https://aeronet.gsfc.nasa.gov/>) site in Belsk (~50 km to the south of Warsaw). However, the data obtained at both sites are not directly comparable in this period due to complicated meteorological conditions of the quasi-stationary weather front.’.**

Pg13Ln31-34: Better remove this sentence.

**Thank you. This is removed.**

Pg14Ln15-16: What does this finding show?

**The following sentence is added: ‘This being in relation to water uptake by the particles.’.**

Pg28: Can you overlay the position of the EARLINET sites of Poland? If the empty dots correspond to the sites, make sure to change the size, or colour, or icon.

**This paper concerns the data sets obtained at the only one Raman lidar EARLINET site in Poland. We indicated the Warsaw EARLINET site with an arrow.**

Pg29: Consider removing this figure or keep the figures related to the reanalysis data.

**The comment was followed as suggested; we left only the trajectories obtained using reanalysis data. Thank you.**

Pg31: A legend is required for Fig. 5. Also, why don’t you report the profiles of lidar ratio and Ångström exponent? The profiles will give an insight into the aerosol layers. Furthermore, the figures are poorly rendered. Make sure to improve the quality of the Figures 5, 6, and 7.

**Thank you for the comment. The legend has been added to Fig 5. We will improve the quality of the Figures 5, 6, 7. We agree that it is possible to have the selection of each layer based on the**



**intensive parameters but a lot of averaging/smoothing have to be done to do properly this selection. This mean that the extensive parameters will be also averaged a lot when one interprets the data obtained in such way. Nevertheless the microphysical inversion depends on the quality of the optical data. Thus the selection of many thin layers is in advantage for the microphysical inversion. This is why we prefer to stick with the proposed approach.**

Pg32: Consider a legend describing the colours or incorporate this information in the colour-bar. In Fig. 7a, the layers 7 and 8 are not discernible. In Fig. 7b, merge layers 6-7. You could have the same colour for layers that correspond to the same aerosol type. E.g. L1 in both layers corresponds to pollution.

**Thank you for the comment. Several legends have been added to Figures 5, 6, and 7. We prefer not to combine the pollution layers together, as they are distinctly different due to the relative humidity.**

### **Technical Comments**

Thank you for all the technical comments. We have considered all of them in revised version, including the revision of sentences.

Pg1Ln8: Add 'the' after 'during'.	<b>Authors: Done.</b>
Pg1Ln8: The 'th' is not needed in the date.	<b>Authors: Done.</b>
Pg1Ln9: Add 'the' before 'so-called'.	<b>Authors: Done.</b>
Pg1Ln10: Replace 'The' with 'A'.	<b>Authors: Done.</b>
Pg1Ln11: Write 'optical properties of 116 layers' instead of 'properties within 116 sublayers in the profiles'.	<b>Authors: Done.</b>
Pg1Ln13: Add 'the' before 'aerosol/mixture'.	<b>Authors: Done.</b>
Pg1Ln16: Replace 'characteristic for' with 'characteristic for'.	<b>Authors: Done.</b>
Pg1Ln16: Delete 'scattered'.	<b>Authors: Done.</b>
Pg1Ln18: Delete '4.8'.	<b>Authors: Done.</b>
Pg1Ln18: Replace 'were' with 'was'.	<b>Authors: Done.</b>
Pg1Ln24: Replace 'studying of' with 'studying the'.	<b>Authors: Done.</b>
Pg1Ln26: Add 'the' before 'microphysics'.	<b>Authors: Done.</b>
Pg1Ln26: Delete 'forming in the presence of aerosols'.	<b>Authors: Done.</b>
Pg1Ln27: Replace 'particles' with 'particle'.	<b>Authors: Done.</b>
Pg1Ln28: Add 'the' before 'aerosol'.	<b>Authors: Done.</b>
Pg1Ln28: Delete 'suspension'.	<b>Authors: Done.</b>
Pg2Ln2: Replace 'what' with 'which'.	<b>Authors: Done.</b>
Pg2Ln8: Replace 'consist' with 'consists'.	<b>Authors: Done.</b>
Pg2Ln9: Replace 'is the subject of' with 'is subject to'.	<b>Authors: Done.</b>
Pg2Ln9: Replace 'processes' with 'process'.	<b>Authors: Done.</b>
Pg2Ln9: Replace 'lead' with 'leads'.	<b>Authors: Done.</b>
Pg2Ln10: Replace 'evolutions' with 'change'.	<b>Authors: Done.</b>
Pg2Ln11: Delete ',' after 'fact'.	<b>Authors: Done.</b>
Pg2Ln13: Add 'the' before 'development'.	<b>Authors: Done.</b>
Pg2Ln13: I do not understand 'yield in the'.	<b>Authors: Rephrased.</b>
Pg2Ln13: Replace 'allow' with 'allows'.	<b>Authors: Done.</b>
Pg2Ln14: Add 'the' before 'characterization'.	<b>Authors: Done.</b>
Pg2Ln14-15: Please rephrase 'a signal depolarization by unspherical particles'.	<b>Authors: Rephrased.</b>
Pg2Ln15: Replace 'unspherical' with 'aspherical'.	<b>Authors: Done.</b>
Pg2Ln17: Delete 'the' after 'during'.	<b>Authors: Done.</b>
Pg2Ln19: Replace 'the' with 'a'.	<b>Authors: Done.</b>
Pg2Ln21: Delete 'the' after 'by'.	<b>Authors: Done.</b>
Pg2Ln21: Please rephrase 'to increase the research quality and reliability'.	<b>Authors: Rephrased.</b>
Pg2Ln23-24: Please rephrase 'The automatic aerosol typing algorithms operate with...'.	

**Authors: Rephrased.**

Pg2Ln24: The abbreviation is missing. Make sure to include abbreviations throughout the manuscript with specific references and website links when needed. **Authors: Done.**

Pg2Ln27: Add 'a' before 'maximum'. **Authors: Done.**

Pg2Ln28: Replace 'This' with 'these'. **Authors: Done.**

Pg2Ln29: Delete 'a very'. **Authors: Done.**

Pg2Ln29: Please rephrase 'to use the lidar data by the specialist'. **Authors: Rephrased.**

Pg2Ln31: Delete 'a' before 'high'. **Authors: Done.**

Pg2Ln33-34: Please rephrase the last sentence. **Authors: Rephrased.**

Pg3Ln1-2: Please rephrase the first sentence. **Authors: Rephrased.**

Pg3Ln2: Delete 'A'. **Authors: Done.**

Pg3Ln3: Delete 'a' before 'long'. **Authors: Done.**

Pg3Ln5-6: What do you mean 'found in the systematic observations'? **Authors: Rephrased.**

Pg3Ln6-8: Also, what does this sentence mean? The message is not clear. **Authors: Rephrased.**

Pg3Ln9: Delete 'a' before 'favourable'. **Authors: Done.**

Pg3Ln14: Replace 'according with' with 'according to', however, I do not think that fits here.

**Authors: Rephrased.**

Pg3Ln16: Replace 'were' with 'was'. **Authors: Done.**

Pg3Ln16: Replace 'based on' with 'using'. **Authors: Done.**

Pg3Ln18: 'which coincide with the analysed in the paper'. What do you mean? **Authors: Rephrased.**

Pg3Ln19: Replace 'aerosol' with 'aerosols'. **Authors: Done.**

Pg3Ln19: Write 'as biomass burning smoke from Ukrainian wildfires'. **Authors: Done.**

Pg3Ln20-21: What do you mean by 'deepening study'? **Authors: Rephrased.**

Pg3Ln21: Please rephrase 'to reflect atmospheric variability and to catch all individual sublayers'. **Authors: Rephrased.**

**Authors: Rephrased.**

Pg3Ln22: What do you mean by 'can be likely kinds of mixtures'? **Authors: Rephrased.**

Pg3Ln23: Delete 'the' before 'separation'. **Authors: Done.**

Pg3Ln28-29: Please rephrase 'as the one... in each sub-layer'. **Authors: Rephrased.**

Pg3Ln29: Delete 'mentioned'. **Authors: Done.**

Pg3Ln30: Please rephrase 'performed as a standard'. **Authors: Rephrased.**

Pg3Ln31: Add 'the' before 'study'. **Authors: Done.**

Pg3Ln32-34: Please rephrase the last sentence. Also, a reference is missing. **Authors: Rephrased.**

Pg4Ln1: Replace 'contain' with 'contains'. **Authors: Done.**

Pg4Ln1-6: The abbreviation 'Sect.' should be used when it appears in running text. **Authors: Done.**

Pg4Ln5: Replace 'is' with 'are'. **Authors: Done.**

Pg4Ln5: Please rephrase 'outlooks potential use of the obtained results'. **Authors: Rephrased.**

Pg4Ln10: Replace 'as' with 'following'. **Authors: Done.**

Pg4Ln15: Replace 'consist of the' with 'consists of a'. **Authors: Done.**

Pg4Ln20: Add 'an' after 'where'. **Authors: Done.**

Pg4Ln23-24: Add 'the' before 'particle' and 'water'. **Authors: Done.**

Pg4Ln26: Replace 'Baars et al., 2016' with 'Baars et al. (2016)'. Make sure when you are citing a paper to comply with the guidelines of ACP. Several mistakes of this kind were found throughout and it is not possible to list them all out. **Authors: Done.**

Pg4Ln28: For the dates, consider using dashes and not slashes. E.g. 9-10 August. **Authors: Done.**

Pg5Ln2: Replace 'meteorology' with 'meteorological'. **Authors: Done.**

Pg5Ln4: Add 'the' before 'retrieval'. **Authors: Done.**

Pg5Ln9: Add 'the' before 'free'. **Authors: Done.**

Pg5Ln14: You refer to 'the latter', which is the former? **Authors: Rephrased.**

Pg5Ln19: Delete 'of' after 'Comparing'. **Authors: Done.**

Pg5Ln19: Delete 'the' after 'showed'. **Authors: Done.**

Pg5Ln20: Add 'the' before 'calculation'. **Authors: Done.**

Pg5Ln20: Delete 'the' before 'mean'. **Authors: Done.**

Pg5Ln23: Add 'for' before 'further'. **Authors: Done.**

Pg5Ln24-25: Delete 'of the intensive optical properties'. **Authors: Done.**

Pg5Ln25: Replace 'sets' with 'set'. **Authors: Done.**

Pg5Ln32: What do you mean by 'aerosol layers occurrence'? **Authors: Rephrased.**

Pg5Ln33: Add 'the' before 'residual'. **Authors: Done.**

Pg6Ln8: Replace 'On the' with 'At the'. **Authors: Done.**

Pg6Ln8: Add 'a' before 'persistent'. **Authors: Done.**

Pg6Ln10: Write 'Inflow of warm air from Western Africa'. **Authors: Done.**

Pg6Ln10: What do you mean by 'was dominating in the troposphere'? **Authors: Rephrased.**

Pg6Ln14: Delete 'the' after 'within'. **Authors: Done.**

Pg6Ln14: I cannot understand 'insensitively'? **Authors: Rephrased.**

Pg6Ln15: Delete 'territory'. **Authors: Done.**

Pg6Ln15: Replace 'In the three days period' with 'In the next three days'. **Authors: Done.**

Pg6Ln15: Replace 'at the direct' with 'located in direct'. **Authors: Done.**

Pg6Ln16 and Pg6Ln18: Delete 'panel'. **Authors: Done.**

Pg6Ln18: Replace 'depict' with 'depicts'. **Authors: Done.**

Pg6Ln18: Add 'the' before 'distinct'. **Authors: Done.**

Pg6Ln19: Replace 'splitted' with 'split'. **Authors: Done.**

Pg6Ln22: Delete 'occurrence'. **Authors: Done.**

Pg6Ln22: What does the sentence 'air settlement in the conditions of high pressure' mean?  
**Authors: Rephrased.**

Pg6Ln23: Delete 'of aerosol structures'. **Authors: Done.**

Pg6Ln25: Replace 'directions of the aerosols inflow' with 'aerosol origin'. **Authors: Done.**

Pg6Ln31: What is a 'high interval'? **Authors: Rephrased.**

Pg7Ln1: What does 'reflect' mean? **Authors: Rephrased.**

Pg7Ln2: Replace 'have' with 'has'. **Authors: Done.**

Pg7Ln3: Add 'the' before 'general'. **Authors: Done.**

Pg7Ln3: Please rephrase 'ran starting on the territory'? **Authors: Rephrased.**

Pg7Ln5: Replace 'At the altitudes' with 'For the altitudes'. **Authors: Done.**

Pg7Ln6: Add 'the' before 'trajectories'. **Authors: Done.**

Pg7Ln6-7: Please rephrase 'from the mentioned before direction of the lower trajectories to the direction from western Europe'. **Authors: Rephrased.**

Pg7Ln7: Add 'the' before 'Czech'. **Authors: Done.**

Pg7Ln7-8: Please rephrase 'Over the time: : : over Spain'. **Authors: Rephrased.**

Pg7Ln9-11: Please rephrase 'At the altitude: : : Sahara Desert'. **Authors: Rephrased.**

Pg7Ln11: Replace 'originate' with 'originates'. **Authors: Done.**

Pg7Ln14: Add 'the' before 'consistency'. **Authors: Done.**

Pg7Ln17: Write 'the two simulations is the origin of the aerosols over Warsaw'. **Authors: Done.**

Pg7Ln21: Replace 'analogous' with 'same'. **Authors: Done.**

Pg7Ln23: Delete 'at the analogous altitudes'. **Authors: Done.**

Pg7Ln28: Delete 'with'. **Authors: Done.**

Pg7Ln28: Add 'the' before 'GDAS'. **Authors: Done.**

Pg8Ln2: The period should be 10-11 August and not 9-11. **Authors: Done.**

Pg8Ln3: Replace 'panel (a)' with 'Fig. 4a'. **Authors: Done.**

Pg8Ln4-5 and Ln14: The same change applies to these sentences. **Authors: Done.**

Pg8Ln5: What do you mean by 'The trajectory altitude is rising...'? **Authors: Rephrased.**

Pg8Ln6: Replace 'as in' with 'to'. **Authors: Done.**

Pg8Ln7: Delete 'the' before 'satellite'. **Authors: Done.**

Pg8Ln9-10: Please rephrase. **Authors: Rephrased.**

Pg8Ln12: Replace 'point that biomass' with 'point out that the biomass'. **Authors: Done.**

Pg8Ln15: Replace 'most likely originates' with 'might have come'. **Authors: Done.**

Pg8Ln16: Delete 'the' before 'copper'. **Authors: Done.**

Pg8Ln16: Add 'the' before 'possible'. **Authors: Done.**

Pg8Ln16: Delete 'the' before 'pollution'. **Authors: Done.**

Pg8Ln16: Add 'the' before 'altitude'. **Authors: Done.**

Pg8Ln17: Replace 'origin' with 'originate'. **Authors: Done.**

Pg8Ln19: Add 'the' before 'Iberian'. **Authors: Done.**

Pg8Ln20: Replace 'origin' with 'originate'. **Authors: Done.**

Pg8Ln21: Replace 'Hungry' with 'Hungary'.	<b>Authors: Done.</b>
Pg8Ln22: Delete 'the' before 'moderately'.	<b>Authors: Done.</b>
Pg8Ln22-23: Please rephrase	<b>Authors: Rephrased.</b>
Pg8Ln26: Replace 'origin' with 'originate' everywhere.	<b>Authors: Done.</b>
Pg8Ln29: What do you mean by 'representative for the layers'?	<b>Authors: Rephrased.</b>
Pg8Ln29: Delete 'the' before 'mean'.	<b>Authors: Done.</b>
Pg9Ln1: Replace 'in further study' with 'for further study'.	<b>Authors: Done.</b>
Pg9Ln1: Delete 'of the intensive properties'.	<b>Authors: Done.</b>
Pg9Ln11: Add 'the' after 'course of'.	<b>Authors: Done.</b>
Pg9Ln11: Add 'A' before 'similar'.	<b>Authors: Done.</b>
Pg9Ln14: Add 'the' before 'data'.	<b>Authors: Done.</b>
Pg9Ln17: Add 'the' before 'slight'.	<b>Authors: Done.</b>
Pg9Ln17: Replace 'from over Sahara' with 'from the Sahara Desert'.	<b>Authors: Done.</b>
Pg9Ln25: Replace 'performed' with 'made'.	<b>Authors: Done.</b>
Pg9Ln31: Please explain 'have some features'.	<b>Authors: Rephrased.</b>
Pg10Ln8: Replace 'splitted' with 'split'.	<b>Authors: Done.</b>
Pg10Ln14: Replace 'in the first' with 'for the first'.	<b>Authors: Done.</b>
Pg10Ln14: Replace 'cooper' with 'copper'.	<b>Authors: Done.</b>
Pg10Ln23: Replace 'domination' with 'dominance'.	<b>Authors: Done.</b>
Pg10Ln23-25: Consider to rephrase this sentence.	<b>Authors: Rephrased.</b>
Pg10Ln26: Please rephrase 'To easy compare'.	<b>Authors: Rephrased.</b>
Pg10Ln28: Replace 'has' with 'have'.	<b>Authors: Done.</b>
Pg10Ln32: Replace 'have' with 'has'.	<b>Authors: Done.</b>
Pg10Ln34: What do you mean by 'stronger contamination'?	<b>Authors: Rephrased.</b>
Pg11Ln1: Delete 'i' from '0.12i' and '0.30i'.	<b>Authors: Done.</b>
Pg11Ln5: Replace 'of' with ','.	<b>Authors: Done.</b>
Pg11Ln7: Replace 'weakly' with 'less'.	<b>Authors: Done.</b>
Pg11Ln8-12: Please rephrase, the message is not clear.	<b>Authors: Rephrased.</b>
Pg11Ln13-14: Please rephrase.	<b>Authors: Rephrased.</b>
Pg11Ln18: Replace 'this' with 'these'.	<b>Authors: Done.</b>
Pg11Ln18: 'This... sr).' What do you mean?	<b>Authors: Rephrased.</b>
Pg11Ln18: Delete 'of' after 'was'.	<b>Authors: Done.</b>
Pg11Ln21: Delete 'of' before 'the BBA'.	<b>Authors: Done.</b>
Pg11Ln27: Delete 'one' before 'case'.	<b>Authors: Done.</b>
Pg12Ln4: Delete ',' after 'shows'.	<b>Authors: Done.</b>
Pg12Ln4: Delete 'rather'.	<b>Authors: Done.</b>
Pg12Ln7: Add 'the' before 'linear'.	<b>Authors: Done.</b>
Pg12Ln7: Delete 'the' before 'details'.	<b>Authors: Done.</b>
Pg12Ln9: I do not get the meaning of 'alternatively'.	<b>Authors: Rephrased.</b>
Pg12Ln9: Write 'the dependence is not linear'.	<b>Authors: Done.</b>
Pg12Ln9-12: Please rephrase.	<b>Authors: Rephrased.</b>
Pg12Ln13: Please rephrase.	<b>Authors: Rephrased.</b>
Pg12Ln14: Replace 'mixture' with 'mixtures'.	<b>Authors: Done.</b>
Pg12Ln16: Replace 'another' with 'other'.	<b>Authors: Done.</b>
Pg12Ln16: Please rephrase 'another stage... atmosphere'.	<b>Authors: Rephrased.</b>
Pg12Ln19: Replace 'splitted' with 'split'.	<b>Authors: Done.</b>
Pg12Ln21: Replace 'this' with 'these'.	<b>Authors: Done.</b>
Pg12Ln23: Replace 'hygroscopicity' with 'the hygroscopic growth'.	<b>Authors: Done.</b>
Pg12Ln24-25: Please rephrase the two sentences. It is impossible to understand.	<b>Authors: Rephrased.</b>
Pg12Ln25-27: Please explain.	<b>Authors: Rephrased.</b>
Pg12Ln27: Delete 'the' before 'model'.	<b>Authors: Done.</b>
Pg12Ln29: Replace 'for' with 'to'.	<b>Authors: Done.</b>
Pg12Ln29: Add 'the' before 'imaginary'.	<b>Authors: Done.</b>
Pg12Ln32: Replace 'shows' with 'show'.	<b>Authors: Done.</b>
Pg12Ln33: Delete 'the' before 'negative'.	<b>Authors: Done.</b>

Pg13Ln1-2: Please rephrase. It is impossible to understand.	<b>Authors: Sorry, rephrased.</b>
Pg13Ln2-4: Please rephrase. It is impossible to understand.	<b>Authors: Sorry, rephrased.</b>
Pg13Ln6: What do you mean by 'assessed'?	<b>Authors: Rephrased.</b>
Pg13Ln17: Add 'the' before 'troposphere'.	<b>Authors: Done.</b>
Pg13Ln17: Add 'the' before 'aerosol'.	<b>Authors: Done.</b>
Pg13Ln17: Delete 'the' before 'observed on that days'.	<b>Authors: Done.</b>
Pg13Ln17: Replace 'were' with 'was'.	<b>Authors: Done.</b>
Pg13Ln18: Pleas rephrase 'present a consistent course'.	<b>Authors: Rephrased.</b>
Pg13Ln19: Add 'the' before 'radiometer'.	<b>Authors: Done.</b>
Pg13Ln20: Replace 'this' with 'the'.	<b>Authors: Done.</b>
Pg13Ln22: I cannot understand 'what'.	<b>Authors: Rephrased.</b>
Pg13Ln26: Delete 'an' before 'aerosol'.	<b>Authors: Done.</b>
Pg13Ln26: Delete 'the' before 'biomass'.	<b>Authors: Done.</b>
Pg13Ln28: Replace 'show' with 'showed'.	<b>Authors: Done.</b>
Pg13Ln29: Write 'that 2-3 days old air from Germany...'	<b>Authors: Done.</b>
Pg13Ln30: Delete 'about'.	<b>Authors: Done.</b>
Pg13Ln31: Replace 'is' with 'in'.	<b>Authors: Done.</b>
Pg14Ln1: 'specifying: : : sub-layers'. Please rephrase.	<b>Authors: Rephrased.</b>
Pg14Ln3: Add 'A' before 'total'.	<b>Authors: Done.</b>
Pg14Ln4: Replace 'o' with 'of'.	<b>Authors: Done.</b>
Pg14Ln4-5: 'general: : : approach'. Please rephrase.	<b>Authors: Rephrased.</b>
Pg14Ln8-9: 'slight: : : possible'. Please rephrase.	<b>Authors: Rephrased.</b>
Pg14Ln9: Add 'the' before 'upper'.	<b>Authors: Done.</b>
Pg14Ln9: Replace 'were' with 'was'.	<b>Authors: Done.</b>
Pg14Ln10-11: 'In one layer: : : information'. Please rephrase.	<b>Authors: Rephrased.</b>
Pg14Ln11: Replace 'do' with 'does'.	<b>Authors: Done.</b>
Pg14Ln11: Replace 'an' with 'a'.	<b>Authors: Done.</b>
Pg14Ln11-13: Please rephrase 'occurs: : : formation)'. Pg14Ln17: Replace 'of some kinds of mixtures' with 'mixed'.	<b>Authors: Rephrased.</b>
Pg14Ln23-24: Please rephrase.	<b>Authors: Rephrased.</b>
Pg27: Insert the following 'black dots depict the', 'calculated with the', 'purple bars depict the', 'estimated from'.	<b>Authors: Done.</b>
Pg27: Replace 'selected to the evaluation' with 'selected for evaluation'.	<b>Authors: Done.</b>
Pg29: Please improve the caption of Figure 3.	<b>Authors: Done.</b>
Pg30: What do you mean by 'the trajectory altitude is rising north-westward'?	<b>Authors: Rephrased.</b>
Pg31: Replace 'in further analysis' with 'for further analysis'.	<b>Authors: Done.</b>
Pg32: Insert the following 'the same colour depicts' and 'layer 8 depicts'.	<b>Authors: Done.</b>
Pg32: Delete 'further' wherever appears in the caption.	<b>Authors: Done.</b>
Pg33: Please rephrase the last sentence of the caption.	<b>Authors: Rephrased.</b>