Dear Editor,

The authors gratefully thank you for your comments and suggestions. We have revised our manuscript to address these suggestions and comments. All the changes and responses to the comments are listed. Additionally, the manuscript has been thoroughly revised by a professional language editing service. We hope our work could satisfy the editor. Our answers to each question have been marked in blue text. The annotated line numbers refer to the revised copy of the manuscript.

I had asked you to seek help for language editing and that particular attention should be paid to the correct use of tenses and singular/plural. Here are some examples from the abstract where this was not taken care of. – Please note that I did not list all other instances in the remainder of the manuscript. Please also refer to the journal guidelines https://www.atmospheric-chemistry-andphysics.net/policies/guidelines_for_authors.html and use the example of the conclusions there to use consistent tenses. Conclusions (also throughout the result/discussion section) should be in present tense (it is shown, we suggest, we conclude, it is demonstrated, the relationship reflects … etc)

Response: Thanks for the comments and suggestions. The manuscript has been thoroughly revised by a professional language editing service.

l. 22: Aqueous-phase oxidation serve… should be 'serves' (singular)

l. 24: Here, we reported … should be 'report' (present tense)

l. 30: "These findings highlighted …" should be 'highlight' (present tense)

l. 32: "The mean aerosol absorption Ångström exponents […] was…" – should be were (plural)

Response: Thanks for the editor's comment. We have provided a point-to-point response to these comments (lines 22–32). It has been revised accordingly in the revised manuscript. Additionally, the manuscript has been thoroughly revised by a professional language editing service.

l. 26/27: “The results show that aqSOA mainly originated from aged biomass-burning emissions via aqueous-phase reactions rather than from photochemical reactions, …”

and

l. 519/520: “..less oxidized SOA were predominantly formed via aqueous-phase reactions instead of photochemical pathways”

See my comment in the previous round: The distinction between aqueous vs photochemical reactions does not make sense. Many aqueous phase reactions are photochemical.

Response: We thank the editor for this important clarification and for pointing out the imprecise wording in the abstract and main text. We fully agree with the editor's comment that many aqueous-phase reactions are indeed photochemical (e.g., OH radical production in the aqueous phase, photolysis of chromophores in aerosols/droplets). Therefore, contrasting "aqueous-phase reactions" with "photochemical reactions" as mutually exclusive pathways is scientifically inaccurate. It has been revised accordingly in the revised manuscript: "Results indicate that aqSOA mainly originated from aged biomass-burning emissions through aqueous-phase processing rather than from gas-phase photochemical oxidation, particularly under high aerosol liquid water content conditions during pollution periods." **(Lines 25–28)** and "These results suggested that less oxidized SOA was predominantly formed through aqueous-phase processing instead of gas-phase photochemical oxidation during PP (Kim et al., 2019; Zhao et al., 2019)." **(Lines 525–527)**.

In addition, we have reviewed the manuscript to ensure that similar phrasing elsewhere has been corrected accordingly. We appreciate the editor's continued guidance in improving the scientific precision of our manuscript.

l. 59: ‘also’ can be removed

l. 66: ‘components’ misspelled

l. 68 ‘would’ seems redundant

l. 78: ‘derives’ seems a wrong word here

l. 82: ‘with’ should be ‘which’

l. 152: remove ‘the’

Response: Thanks for the editor's comment. We have provided a point-to-point response to these comments (lines 59–152). It has been revised accordingly in the revised manuscript. Additionally, the manuscript has been thoroughly revised by a professional language editing service.

l. 160ff: “The scattering effects of quartz filters were modified automatically by a fixed multiple scattering parameter (2.14)” – It is not clear what was done.

Response: We thank the editor for this comment and appreciate the opportunity to clarify the correction procedure applied to the aethalometer data. In the original manuscript, we described the correction as "modified automatically by a fixed multiple scattering parameter (2.14)," which was indeed insufficiently clear. We apologize for the ambiguity and have revised accordingly in the revised manuscript: "The scattering effects of quartz filters were modified automatically by a fixed multiple-scattering parameter (2.14) (SI Text S3)." **(Lines 160–162).** Additionally, we have revised the description in the Supporting Information (SI Text S3) to provide a more detailed and accurate explanation:

"**Text S3.** Estimation of BC and BrC Absorption

Aerosol light absorption (Abs_{λ}) was caused by black carbon (BC) ($Abs_{\lambda,BC}$) and brown carbon (BrC) ($Abs_{\lambda,BrC}$). In this study, the Abs_{λ} value was measured in real time by AE33 (Magee Scientific) at seven wavelengths (i.e., 370, 470, 520, 590, 660, 880, and 950 nm) (Drinovec et al., 2015). Previous research indicated that Abs_{λ} measured by Aethalometer was influenced by the scattering effects of quartz filters and nonlinear loading effects (Coen et al., 2010). This study implemented real-time corrections for loading effects based on the parallel measurements of attenuation values (ATN1 and ATN2) from the AE33 (Drinovec et al., 2015):

$$\frac{Q_2}{Q_1}\times \mathrm{FVRF}=\frac{\ln(1-k\times \mathrm{ATN}_2)}{\ln(1-k\times \mathrm{ATN}_1)} \quad \text{(S5)}$$

$$k_{\mathrm{weighted}}=\frac{(\mathrm{ATN_{TA}}-\mathrm{ATN_1})\times k_{\mathrm{old}}+(\mathrm{ATN_1}-\mathrm{ATN_{f2}})\times k}{(\mathrm{ATN_{TA}}-\mathrm{ATN_{f2}})} \quad \text{(S6)}$$

$$\mathrm{Abs}_{\lambda}=\frac{A\times(\Delta \mathrm{ATN}_{1,\lambda}/100)}{Q_1\times(1-\delta)\times C_{\lambda}\times(1-k\times \mathrm{ATN}_{1,\lambda})\times \Delta t} \quad \text{(S7)}$$

where A and Q are the spot size and flow rate onto which particles are collected over a certain time period (t), respectively; C_λ is factor to compensate for multiple scattering of the filter fibers. In this study, the scattering effects of quartz filters were modified automatically by a single C value of 2.14 for all wavelengths (Weingartner et al., 2003). The value of δ, the lateral airflow in the filter matrix under the optical chamber, is determined by measuring of input and output flow; the face velocity ratio factor (FVRF) is determined from the ATN_2/ATN_1 ratio obtained at low filter loadings (Drinovec et al., 2015). The parameter k is determined by numerically solving the Eq. (S5). ATN_{f2} and ATN_{TA} are the upper limit on the attenuation range and attenuation setting to trigger the tape advance (typically around 120 at 370 nm), respectively. A weighted value of the parameter k ($k_{weighted}$) is used for loading effect compensation. It should be noted that the different compensation algorithms might yield slightly different Abs_λ. However, the comparison of these approaches or the improvement of the compensation methodology used is beyond the scope of this study." **(Lines 135–160).**

l. 169: Please adhere to the journal standards regarding the citation of websites that demands that the last access date is added: https://www.atmospheric-chemistry-and-physics.net/submission.html

Response: Thanks for the editor's comment. It has been revised accordingly in the revised manuscript.

l. 186 and 189 (and maybe other instances): add 'the' before ToF-ACSM

l., 190ff: "As shown in Fig. S2, the average ratio of the measured NH4 to the predicted NH4 needed to fully neutralize the SO4, NO3 and Chl was approximately 1." I do not understand this sentence. Structure and/or grammar seem wrong.

l. 241, 244 and 257: Please adhere to the standards of the journal: Equations should be numbered sequentially with Arabic numerals in parentheses on the right-hand side, e.g. (1), (2). https://www.atmospheric-chemistry-and-physics.net/submission.html

l. 257: should 'as' be 'is'?

l. 311: It should be 'AqSOA' because it is at the beginning of a sentence.

l. 311: “AqSOA correlated with…” seems to be inconsistent in tense with that in l. 317 (was [..] correlated)

l. 325: “These results demonstrated BBOA as the dominant component of OA in autumn in the SCB” – demonstrated doesn’t seem the right word here. ‘Identified’ might fit better or rephrase ‘We demonstrated…’

l. 361: ‘increasing’ should be ‘increase’

l. 390: remove the duplicate ‘ratio’

l. 490: “The f60 value of OOA was 0.002, lower than the typical background level (0.003) observed in the atmospheric unaffected by biomass burning.” – This sentence seems grammatically wrong.

l. 508: ‘cam’ should be ‘can’

l. 533: ‘the’ missing before overall dataset

l. 557: ‘regional’ should be ‘regionally’

l. 570: ‘was also shown’ should be ‘is also shown’

l. 617: ‘were’ should be ‘are’

l. 624: ‘were’ should be ‘are’

Response: Thanks for the editor's comment. We have provided a point-to-point response to these comments (lines 186–624). It has been revised accordingly in the revised manuscript. Additionally, the manuscript has been thoroughly revised by a professional language editing service.

l. 658: What is the mass concentration of NO_2? Do you really mean the gas here or nitrite?

Response: We thank the editor for this careful observation and the opportunity to clarify this point. In the manuscript, NO_2 refers specifically to gaseous nitrogen dioxide, not to nitrite (NO_2^-). Its measurement is described in Section 2.2 (Instrumentation), where we specified that gaseous NO_2 was measured by gas analyzers (42i, Thermo Scientific), which measures gas-phase NO_2 via chemiluminescence combined with molybdenum converter conversion. The concentrations of gaseous NO_2 are now clearly reported in the revised manuscript for transparency: "The average concentrations of O_3 and NO_2 during the campaign

were 24.8 ± 16.1 ppb and 14.2 ± 6.8 ppb, respectively." **(Lines 278–279)** and "Additionally, the average concentrations of NO_3, NH_4, and NO_2 from 17:00 to 03:00 LT (9.1 μg m^{-3}, 5.6 μg m^{-3}, and 16.0 ppb, respectively) were 1.2, 1.2, and 1.3 times those from 04:00 to 16:00 LT (7.7 μg m^{-3}, 4.7 μg m^{-3}, and 12.6 ppb, respectively)." **(Lines 665–667).** We appreciate the editor's attention to this detail, which has helped improve the clarity and precision of our manuscript.

l. 664: Two glyoxal molecules are not sufficient to make an oligomer but only a dimer

Response: We sincerely thank the editor for this careful and insightful comment regarding the terminology used to describe the reaction products of glyoxal. The editor correctly points out that a reaction involving only two glyoxal molecules forms a dimer, not an oligomer. We acknowledge that our original phrasing, "oligomers (involving two glyoxal molecules)," was imprecise. After carefully reviewing the cited literature, we confirm that these studies indeed describe the formation of oligomers (which can include dimers, trimers, and higher-order polymers) from aqueous reactions of glyoxal with NH_3. The parenthetical specification "involving two glyoxal molecules" was an inaccurate addition on our part. Accordingly, we have revised the sentence to accurately reflect the original literature: "Previous studies have shown that oligomers formed through aqueous reactions of glyoxal with NH_3, which contain C=C or C=N bonds, exhibit strong absorption in near-UV regions (Laskin et al., 2015; Lee et al., 2013; Nozière et al., 2009; Powelsonet al., 2014)." **(Lines 672–675).**

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Manuscript Title

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