AUTHOR'S RESPONSE TO EDITOR'S REVIEW

Manuscript: egusphere-2025-1776

We thank the editor and the two reviewers for their careful reading and constructive suggestions. The revision clarifies methods, corrects processing issues affecting low-signal periods, and documents all screening and trend procedures at the code level. The main physical conclusions are unchanged. The analysis is now more transparent, reproducible, and all affected figures, captions and line-referenced methods have been updated.

We identified and removed a duplicate truncation correction that had been inadvertently applied to the nephelometer scattering coefficients; reprocessing reduces near-zero artefacts and all affected figures and tables were regenerated. The cross-instrument AE33–MAAP comparison is now fully specified with explicit thresholds and clear explanation of the underlying code. The AE33–MAAP screening and fit criteria are instrument-agnostic. We apply uniform detection limits of 0.05 Mm^{-1} to both AE33 (660 nm) and MAAP (637 nm), use a five-sample stuck-value filter for each instrument, and enforce a simple agreement rule: we keep only pairs where neither instrument exceeds the other by a factor of five. Using an ordinary least-squares fit with an intercept, the updated relationship has $R^2 = 0.96$ (Figure R1).

In addition, Figures 1 and 2 were redrawn for clarity as per the editor's comments. Individual responses to the reviewers' comments have been provided below.

Response to Reviewer 1

General comments: This study examines the long-term variability of aerosol optical properties in a boreal forest, categorised by size range. It focuses particularly on the contribution of particles larger than 10 µm, which are usually not considered in aerosol studies as this is the inlet cut-off point. As aerosol optical properties directly influence their radiative effect and larger diameter particles contribute significantly to the AOD, this topic is of great interest for climate modelling parameterisation. Using absorption and scattering measurements coupled with an impactor, the authors investigated the relative contribution of each PM size range to extensive and intensive scattering and absorption parameters. This study's novelty lies in its use of an aerosol classification for PM10, highlighting the significant impact of episodic events such as pollen and dust on optical properties and PM mass. The conclusions provide clear evidence of shifts in the size distribution and composition of aerosols, as well as their seasonality, which are linked to anthropogenic and biogenic emissions. The manuscript is well written and structured. However, several passages are redundant (e.g. the enhanced contribution of dust to the increasing SAE in sections 3.3.2 and 3.3.3), as are some details on the classification matrix (see specific comments). This paper would benefit from being shortened slightly. More importantly, the correction for multiple scattering on the instrument measuring absorption (AE33) was not properly discussed, as it appears to be misunderstood. This is important because it could also explain some discontinuities in the time series from 2018. I consider the manuscript to be publishable after minor revisions and responses to the following points.

Response: Thank you for taking out the time to review our manuscript in such detail. As a general remark, we have now revised the whole manuscript to avoid redundancies. As you had rightly pointed out, the multiple scattering correction factor for the AE31/33 was not properly discussed, which has been addressed now. In fact, a lot of the discontinuities post-2018, actually arose from the truncation correction, being doubly applied to the data of the light scattering coeffcients. This issue has also been corrected and we hope that the revised manuscript addresses all the comments that you have raised.

Comment l.139: Are you sure that the AE33 adjusts the Cref value taking into account aerosol concentrations and environmental conditions? The C value is fixed in the instrument settings, adjustable by the user, and depends on filter material and type.

Response: As outlined in the AE33 manual, the multiple-scattering correction factor (C_{ref}) is fixed in the instrument settings and must be defined by the user. It is determined by the instrument configuration—particularly the filter tape—and does not adjust automatically to ambient conditions. For consistency, we used two fixed, filter-specific values: C_{ref} = 1.57 for 2010–2017 (AE31 with M8020; Luoma et al., 2019) and C_{ref} = 1.39 for 2018–2022 (AE33 with M8060). Yus-Díez et al. (2021) report that the C_{ref} can increase with SSA, but we did not implement environment-dependent adjustments; our choice follows manufacturer guidelines and reflects only the filter properties.

Response Lines: 140-141.

Comment l.356–363: If the absorption coefficient decrease is statistically significant, why are absorbing aerosols less present than in 2010? Are instrumental differences a major contributor?

Response: The absorbing aerosols are "less present" than in 2010 because the fine fraction—which dominates light absorption—has declined. At SMEAR II, $\sigma_{abs,520}$ decreases significantly for PM_{10} (-0.11 ± 0.03 Mm^{-1} yr^{-1}; -8.75 ± 2.11 % yr^{-1}; Fig. S1b; Table S3b) and PM_1 (-0.09 ± 0.02 Mm^{-1} yr^{-1}; -8.87 ± 2.18 % yr^{-1}; Fig. S2b; Table S4b). The similar relative declines indicate that the PM_{10} decrease is likely dominated by its PM_1 (fine-mode) contribution at 520 nm. This is consistent with documented Europe-wide reductions in black-carbon emissions and long-term declines in aerosol absorption over the last decade (Collaud Coen et al., 2020; Yttri et al., 2021). We do not infer a robust long-term decrease for the coarse fraction (PM_{1-10}): its $\sigma_{abs,520}$ trend is negative but not statistically significant, which is compatible with the episodic, weakly absorbing nature of mineral and biological coarse particles at the site.

Instrumental differences are unlikely to be a major contributor. All absorption data were processed in a harmonized pipeline across the AE31-AE33 transition, including fixed multiple-scattering and filter-loading corrections appropriate to instrument/filter configuration, MAAP intercomparisons where applicable, and uniform QA/QC and completeness criteria (see Methods). Three checks argue against an instrumental origin: (i) no step change is observed at the 2018 transition; (ii) the negative trends persist within each instrument period when analyzed separately; and (iii) the physical seasonality (winter maxima, late-spring minimum) is stable through the record. While small biases associated with filter media and algorithms are possible in principle

(Collaud Coen et al., 2010; Zotter et al., 2017), sensitivity tests using plausible parameter choices do not alter the sign or the significance of the PM_{10}/PM_1 trends. Thus, the observed declines are best explained by real source-side reductions in absorbing aerosols rather than by instrumental artifacts.

Response Lines: 421-428.

Comment l.398: AE33 uses a constant, tape-dependent Cref, but Yus-Díez et al. (2021) showed C also depends on site SSA. Was the AE33 Cref appropriate?

Response: The AE33 does not dynamically adjust the multiple-scattering factor C_{ref} during operation; it uses a fixed, tape-specific value. Consistent with site practice (Luoma et al., 2019), we used C_{ref} = 1.57 for AE31 with M8020 (2010–2017) and C_{ref} = 1.39 for AE33 with M8060 (2018–2022). Monthly $\sigma_{abs,520}$ boxplots for PM_{10}, PM_1 and $PM_{1\text{–}10}$ show the same late-spring to mid-summer minimum across 2010–2022 with no shape change at 2018. Because the retrieved absorption scales as $\sigma_{abs,520} \propto 1/C_{ref}$, the increase of the effective C_{ref} at high SSA (Yus-Díez et al., 2021) implies that using a fixed 1.39 in summer slightly overestimates $\sigma_{abs,520}$; this would flatten (not deepen) the summer minimum. A constant C_{ref} choice only rescales the AE33 segment: substituting 1.57 for 1.39 multiplies it by 1.39/1.57=0.8851.39/1.57=0.8851.39/1.57=0.885 (≈11.5 % lower), which cannot shift the month of the minimum or reverse trend signs. Thus, the adopted AE33 C_{ref} is appropriate and does not explain the seasonal summer minimum in $\sigma_{abs,520}$, nor can it alter the sign or timing of long-term trends in $\sigma_{abs,520}$, since a constant C_{ref} only rescales the series. Within the plausible range for M8060, our conclusions are insensitive to the exact C_{ref}. Changes affect only magnitude, not seasonal phase or trend sign. Moreover, because the effective CCC increases under high-SSA summer conditions, a fixed 1.39 would slightly overestimate summer $\sigma_{abs,520}$ and thus flatten, rather than deepen, the observed minimum.

Comment Part 3.3.2: Much higher variability of SAE after 2018: is there an abrupt change at one nephelometer wavelength?

Response: The apparent post-2018 increase in $PM_{1\text{–}10}$ *SAE* variability was a processing artefact: a duplicate truncation correction had been applied to σ_{sca} at 450, 550 and 700 nm. After reprocessing (single application only), the inflated variability disappears. The remaining variability reflects real shifts in the supermicron size mix (relatively larger particles → lower *SAE*; relatively smaller particles → higher *SAE*). Addressing the second point, no wavelength shows an abrupt change: $PM_{1\text{–}10}$ σsca at 450/550/700 nm vary smoothly with non-significant p-values (0.09/0.18/0.34), and PM_1/PM_{10} exhibit similarly smooth behaviour. We updated the processing and regenerated the *SAE* plots accordingly.

Comment l. 486-487: But then if the MSC decreases because of the lower sulfate mass fraction within PM_1, why does the MSC time series has a positive trend ?

Sulfate aerosol particles are highly efficient light scatterers, and a decline in sulfate mass fraction would be expected to reduce MSC_{550}. The earlier positive trend in the MSC_{550} of the PM_1 aerosol particles conflicted with this understanding and indicated an inconsistency in the analysis. This was traced to a truncation error caused by the double application of the truncation correction to the nephelometer wavelengths of 450, 550, and 700 nm.

Correcting this error restored the light scattering coefficients at 550 nm ($\sigma_{sca,550}$) used in the calculation of MSC_{550} ($MSC_{550} = \sigma_{sca,550}/PM\ mass$), and the updated MSC_{550} time series now accurately represent monthly medians for the PM_1, PM_{10}, and $PM_{1\text{-}10}$ aerosol particles.

The corrected analysis shows that MSC_{550} for PM_1 exhibits a non-significant trend, consistent with the reduction in sulfate mass fraction and its effect on scattering efficiency (Pandolfi et al., 2014; Seinfeld & Pandis, 2016). MSC_{550} for PM_{10} and $PM_{1\text{-}10}$ are also non-significant, reflecting the stronger contribution of coarse particles in these fractions, whose scattering efficiency is less sensitive to sulfate changes. These results indicate that sulfate reductions are mainly expressed in PM_1, while the larger size fractions remain buffered by coarse-mode contributions, which dilute the effect of composition on scattering.

The revised MSC_{550} trends are now consistent with the expected effects of sulfate on scattering efficiency across size fractions. The smooth and continuous time series demonstrate that the updated results are free from artefacts and reflect changes in aerosol composition rather than instrumental issues. This correction resolves the earlier inconsistency by linking reductions in sulfate mass fraction directly to the scattering signal in PM_1, clarifying how size-resolved contributions shape MSC_{550} and improving confidence in the interpretation of long-term scattering behavior across all particle size ranges.

Response Lines: 563-572.

Comment from l.398: AE33 still has a constant C_{ref} value, depending on the filter tape. Yus-Diez et al. (2021) have shown that this C value is also depending on the SSA measured at the site. One can wonder whether the C value used in the AE33 was appropriate.

Response: The $\sigma_{abs,520}$ boxplots (Fig. S10) for 2010–2017 and 2018–2022 address whether the seasonal decrease in May–July is consistent across the instrument transition. In both periods, PM_{10}, PM_1, and $PM_{1\text{-}10}$ show clear winter maxima and a pronounced May–July reduction, with no evidence of discontinuities. This stability demonstrates that the decrease is a persistent feature of the boreal aerosol cycle rather than an artefact of instrumentation or data processing.

The AE33 multiple-scattering correction factor (C_{ref}) was applied as a fixed, filter-specific constant. We used C_{ref} = 1.57 for 2010–2017 and C_{ref} = 1.39 for 2018–2022, the manufacturer-recommended values for the M8020 and M8060 filter tapes, respectively (Luoma et al., 2019). Yus-Díez et al. (2021) showed that the effective C_{ref} can increase under high-*SSA* (strongly scattering) conditions, but we did not implement such environment-dependent adjustments here. Because C_{ref} is fixed within each period and independent of *SSA*, it cannot account for or influence the May–July decrease in $\sigma_{abs,520}$ observed in either interval.

Comment l. 517-518: The multiple scattering effect on the AE filter would increase if the SSA is higher (which is the case, regarding Fig 4), leading to a higher correction factor C, and to even lower σ_{abs}, so the correction of this parameter can't really explain the decrease of σ_{abs} during May, June and July. Related to that, do these boxplots (Fig 3 and 4) look the same before and after 2018?

Response: For all three size fractions (PM_{10}, PM_1, and $PM_{1\text{-}10}$), the $\sigma_{abs,520}$ boxplots for 2010–2017 and 2018–2022 show similar seasonal patterns, with clear winter maxima and a pronounced reduction in May–July. The magnitude and timing of this decrease arensistent across both time periods, with no evidence of discontinuities or offsets between the datasets. This stability indicates that the observed May–July reduction is a persistent feature of the boreal aerosol annual cycle and is not attributable to the 2018 instrument transition.

The AE33 multiple-scattering correction factor (C_{ref}) was applied as a fixed parameter for each period, determined by the filter type used. For 2010–2017, we retained C_{ref} = 1.57 following Luoma et al. (2019), appropriate for TFE-coated glass fibre filters. For 2018–2022, we used C_{ref} = 1.39, the recommended value for the Magee M8060 filter tape installed in our AE33. These values were not altered based on aerosol concentration or environmental conditions, ensuring consistency and avoiding potential bias in $\sigma_{abs,520}$ trends.

The SSA_{550} boxplots indicate elevated values during May–July for all size fractions, reflecting the stronger contribution of scattering relative to absorption in this period. While higher SSA_{550} can increase the magnitude of the multiple-scattering effect, the fixed C_{ref} values applied in each period mean that this effect does not influence the observed seasonal σabs reduction. The consistency of SSA_{550} patterns before and after 2018 further supports the interpretation that the May–July σ_{abs} decrease reflects atmospheric variability rather than methodological artefacts.

Comment l. 218 and Fig S9: What is the r^2 value of the linear regression? Did you keep all the AE data, even the one that were far from the slope?

Response: R^2 of the AE33–MAAP linear regression is 0.96 using ordinary least squares with an intercept. The fitted relation is $\sigma_{abs,660}$ (AE33) = 2.33 x $\sigma_{abs,637}$ (MAAP) + 0.16 Mm^{-1} (Figure R1). No, we did not keep all aethalometer data, especially those far from the slope. Points were removed automatically if they failed objective screening. We did not hand-pick points.

Previously, in old Fig. S9 (Figure R2), we used asymmetric low-value thresholds: AE33 ≥ 0.0165 Mm^{-1} and MAAP ≥ 0.165 Mm^{-1}, based on early heuristics and mis-specified limits, partly because AE33 read higher than MAAP in time series (Figure R3). We removed only ≥ plateaus of 10 identical data points, applied a one-sided agreement bound, and performed no residual outlier screening. Result: slope 2.36, intercept 0.08, and R^2 = 0.93. These choices had increased the scatter, although not by much.

Now, in revised Figure S9 (Figure R1), we apply a uniform detection limit of 0.05 Mm^{-1} to both instruments, remove ≥ plateaus of 5 identical data points, and enforce a symmetric plausibility check by excluding pairs where one instrument exceeds fivefold over the other, implemented as not (AE33 ≥ 5 x MAAP or MAAP ≥ 5 x AE33).

This revised treatment improves the R^2 from 0.93 to 0.96.

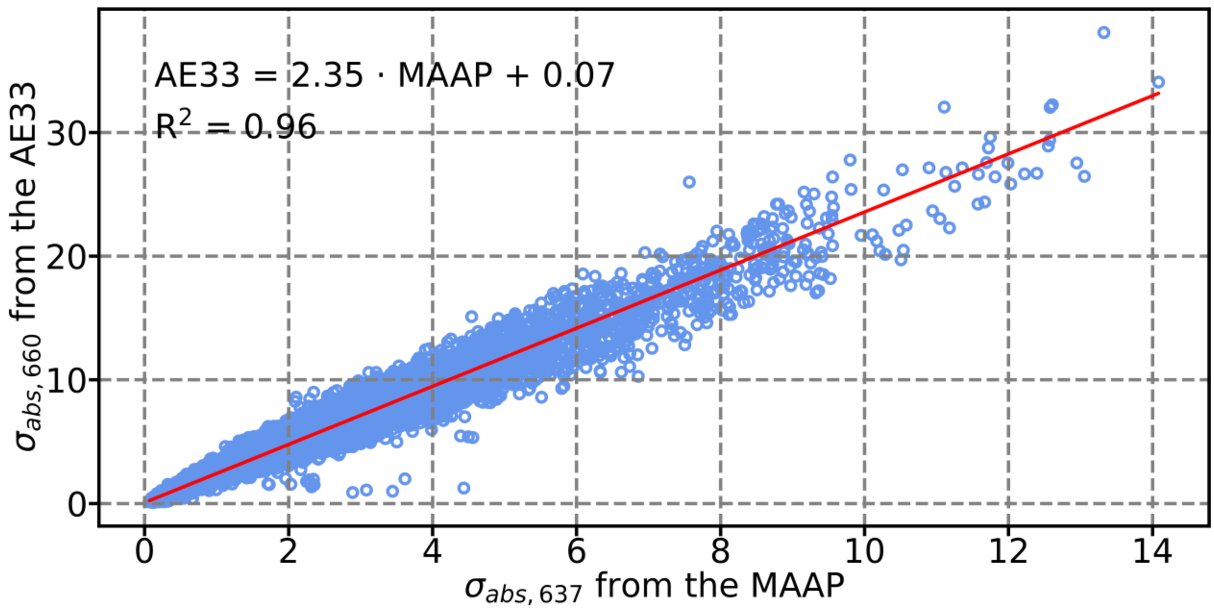

Figure R1. Ordinary least squares regression of $\sigma_{abs,660}$ from the AE33 with respect to $\sigma_{abs,637}$ from the MAAP (New).

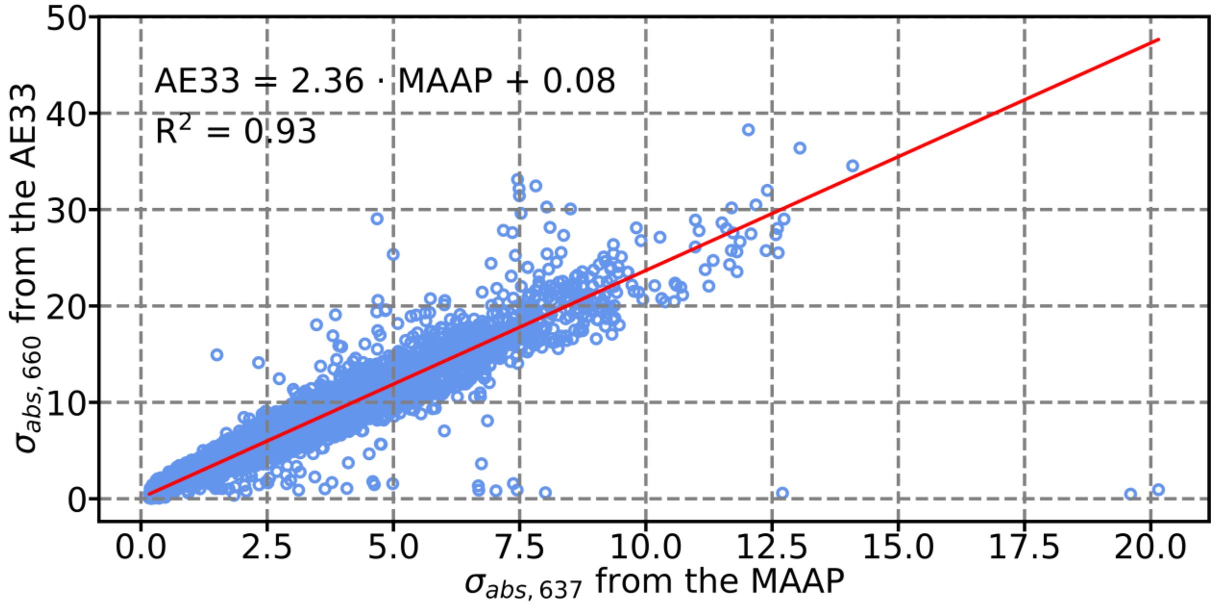

Figure R2. Ordinary least squares regression of $\sigma_{abs,660}$ from the AE33 with respect to $\sigma_{abs,637}$ from the MAAP (Old).

Response Lines: Figure S9.

Technical corrections:

l. 89-90 : "two Magee Scientific Aethalometers"

Response: Error fixed

Response Line: 112.

l. 92-93 : please fix the intervals in the parenthesis : "(i.e. ≤ PM1, between PM1 and PM2.5, between PM2.5 and PM10, ≤ PM10, > PM10)".

Response: Fixed.

Response Lines: 115-116.

l. 106 "aethalometers"

Response: It should be aethalometer instead of aethalometers because any given time, there was only one aethalometer operating. The AE31 was used from 2010 to 2017 and the AE33 was used from 2018 to 2022.

l. 127-128 please fix the citation format.

Response: Fixed.

Response Lines: 849-851.

l. 212 please fix the citation format.

Response: Fixed.

l. 269: "which is used in conversion of σ_{abs} to BC mass"

Response: Corrected.

Response Line: 331.

l. 277-278 : The composition is not a physical characteristic

Response: Corrected to "the physicochemical characteristics of aerosols".

Response Line: 339.

l. 319 : " contribution additional variability" this sentence is strange

Response: Corrected to "Pollen and dust events (green and red stars; Sect. 2.3) introduce additional short-term variability in the observed optical and mass properties without altering the sign or statistical significance of the long-term trends (Table 3)."

Response Lines: 381-384.

Fig 1 and Fig 2: Please provide the meaning of the blue shaded area on panels a and b.

Response: The legend has been changed.

Response Lines: 395-398 and 450-453.

l. 333 : Please provide at least for the first notification the information on the two different values : slope and relative trend.

Response: This has been done everywhere in the paper now, instead of just the first instance, so that the same style is maintained throughout the paper.

l.475 : Why “albeit” ? Statistically significant is not contrasting with the beginning of the sentence.

Response: This section has been changed altogether.

Response Lines: 563-572.

Fig 5 : It would be great to remove the decimal part of the y-axis ticks on panels c and d. Furthermore, it is a bit difficult to see with this representation the contribution of pollen and dust events to Super PM10, as we don’t see on which months occurred these events. Maybe you can add the red and green stars also on panels c and d ?

Response: The decimal part of the y-axis ticks on panels (c) and (d) have been removed. We have added the seasonal variation of dust and pollen events in the figure.

Response Line: 680.

Response to Reviewer 2

We want to thank the reviewer for crticicall examining the manuscript. We hope that the responses below address all your concerns.

Comment Line 225: How does autocorrelation in time series data affect the results of the Mann-Kendall test, and how is this addressed?

Response: The classical Mann–Kendall (MK) trend test assumes serial independence. Positive autocorrelation reduces the effective information in a series; if it is not accounted for, the MK variance is underestimated and the test becomes too liberal (p-values spuriously small). Strong negative autocorrelation has the opposite effect. In other words, persistence can make a weak trend appear “significant” unless the MK variance is adjusted.

We use a variance-corrected MK that replaces the nominal sample size n with an effective sample size,

$$n_{eff} = \frac{n}{1+2\sum\rho_k} \ (\geq 1), \qquad \text{R2}$$

computed from the statistically significant autocorrelation coefficients (ρ_k) of the analysis series. Concretely, our function *effective_sample_size()* evaluates the autocorrelation function (ACF) for lags $k = 1 \ldots n_{\text{lags}}$ with $n_{\text{lags}} = \min(20, \lfloor n/4 \rfloor)$ (lag 0 excluded), retains only lags with $|\rho_k| > 1.96/\sqrt{n}$, and then forms n_{eff}. This n_{eff} is used inside *modified_mann_kendall_trend()* to compute the MK variance and Z statistic, yielding autocorrelation-aware p-values. Importantly, the trend magnitude is estimated with Theil–Sen and is unchanged by this correction; only the significance is adjusted. We do not prewhiten, thereby avoiding potential slope bias.

(i) Pseudo-daily variables—*PM mass*, MSC_{550}, MAC_{520}: in *plot_trend_ps,eudo_daily()* we

(a) mask day-level outliers using a modified Z-score, that is flag x_i if $|0.6745(x_i - \text{median})/\text{MAD}| > 3.5$,

(b) estimate the slope with Theil–Sen, and

(c) test significance with the effective sample size (ESS)–corrected Mann–Kendall test described above. Any day/interval completeness gates are enforced upstream when the pseudo-daily series are constructed; flagged pollen/dust events are annotated for context but not removed.

(ii) Monthly-median variables—$\sigma_{sca,550}$, $\sigma_{abs,520}$, SSA_{550}, *SAE*, *AAE*: we first form monthly medians only when a month has ≥75%age valid hours (based on the native sampling interval), which reduces short-lag persistence; we then fit Theil–Sen and apply the same ESS-corrected MK to the monthly series.

Across both paths, the slope estimator (Theil–Sen) provides a robust trend magnitude, while the MK p-values are explicitly corrected for autocorrelation. This prevents inflated significance due to persistence and yields a conservative, reproducible assessment of trend detection appropriate for environmental time series.

Comment Line 227: How do seasonal fluctuations and non-linear trends influence the interpretation of long-term aerosol optical trends?

Response: Seasonal patterns can skew how long-term change looks. If the size or timing of the yearly cycle shifts—such as weaker winters, earlier or larger spring pollen or dust peaks, or stronger warm-season SOA with frequent spring–autumn NPF—a straight line through the raw series will absorb that movement. The apparent slope can become too big or too small, and in rare cases flip sign. These patterns also create persistence, so ignoring serial correlation can overstate confidence; our inference targets the slow component and uses statistically robust, dependence-aware trend tools (Mann, 1945; Kendall, 1975; Hamed and Rao, 1998; Yue and Wang, 2004).

Non-linear behavior brings a different challenge. Curvature across years, step changes around instrument transitions, and short pollen or dust episodes split the record into periods that do not behave the same way. One constant slope across the full series then averages dissimilar regimes and can misstate what is happening now, even when the overall fit appears good. In practice this can bias both the estimated magnitude and its assessed significance, or shift the mean without altering direction. That is why we examine shape and regime changes before summarizing the record with a single tendency. Effects matter for attribution and interpretation.

We reflect those issues in the analysis pipeline. For PM mass, MSC_{550}, and MAC_{520} we build pseudo-daily means by keeping days with ≥18 time-stamped observations, masking outliers with a modified Z-score, and averaging reliably. For the $\sigma_{sca,550}$, $\sigma_{abs,520}$, SSA_{550}, *SAE*, and the *AAE*, we compute monthly medians when a month has ≥75% valid hours, masking monthly outliers. We report the trend using the robust median slope (Theil, 1950; Sen, 1968) and test it with a statistically conservative Mann–Kendall adjusted for autocorrelation by shrinking the effective sample size using significant ACF lags up to *n_lags* = min(20, ⌊n/4⌋) (Hamed and Rao, 1998; Yue and Wang, 2004).

Comment Line 40: "which could explain higher concentrations in winter." Add “higher coarse particle concentrations in winter."

Response: Now, the introduction section has been changed, so this line is redundant.

Comment Line 41-42: "while pollen and spores often originate from more local biogenic emissions that are highly episodic and seasonal." The phrase "more local" can be improved.

Response: Same as above.

Comment Line 43: "Sea salt, though typically associated with marine environments, can occasionally reach boreal forests during strong winds." Could be written as "can occasionally be transported to boreal forests during strong wind events."

Response: Same as above.

Comment Line 45: Replace "over 10 µm" (line 45) with >10 µm for consistency with earlier notation (e.g., line 23: >1 µm).

Response: Corrected.

Response Line: 46.

Line 45–47: "may not be fully captured by standard PM10 measurements, leaving their contributions underrepresented...". Add the reason here “due to cut-off inlets or sampling loss”.

Response: Line changed to, “Coarse-mode aerosol particle sizes span about 1 µm to > 10 µm, so many pollen grains and fungal spores exceed the PM_{10} impactor cut-off and are underrepresented in PM_{10} measurements (Després et al., 2012; Yli-Panula et al., 2009).”

Line 49:"contribute to atmospheric heterogeneity". Specify "spatial and temporal heterogeneity" for more scientific clarity.

Response: Corrected as advised.

Response Line: 65.

Comment Line 51: the reference added here is in non-chronological citation order. Also, Brasseur et al., 2024 is cited in a 2025-dated document. While plausible (if published in early 2024), ensure this reference exists. If not, update to the correct publication year.

Response: I have used a citation manager tool that created citations as per the author’s last name. That is why Brasseur appears first. Also, the Brasseur et al. was published in 2024 and the link to the correct paper is included in the reference list.

Response Line: 68.

Comment Line 57: "potentially leaving a significant fraction of aerosol mass unquantified". Replace with "potentially resulting in a significant underestimation of aerosol mass."

Response: Done.

Comment Lines 64-68: These line are slightly redundant with earlier statements and too long

Response: This paragraph has been rewritten.

Response Lines: 80-91.

Comment Line 86–87: “Thus, SMEAR II represents the typical conditions that may be found in a boreal forest.” Should be replaced by "Therefore, SMEAR II reflects typical boreal forest conditions."

Response: Changed as advised.

Response Line: 108.

Comment Line 88: “It is a part of the European Aerosols, Clouds, and Trace Gases Research Infrastructure or ACTRIS…” should be replaced by "The station is part of ACTRIS (Aerosols, Clouds, and Trace Gases Research Infrastructure)..."

Response: Done.

Response Line: 111.

Comment Line 60: "such as pollen, may escape standard measurements, whereas smaller coarse-mode particles, such as fungal spores and dust, are more likely to be captured. Replace with "Smaller coarse-mode particles like fungal spores and dust are more likely to be captured, whereas larger ones, such as pollen, may escape detection."

Response: Corrected.

Response Line: 76-77.

Comment Line 77: Define "super-PM_{10}" earlier for clarity:37-48: Provide references for these statements.

Response: Done.

Response Lines: 81-85.

Comment Line 88-93: 4 instruments have been used primarily, but only 3 have been covered here.

Response: Changed.

Response Lines: 108-117.

Comment Line 97: ‘a’ $D_p > 10$ µm

Response: Done.

Response Line: 120.

Comment Line 104: is aimed ‘to’ be kept

Response: Corrected.

Comment Line 120: Are there any recent publications post Liousse et al., 1993 which cover this?

Response: Yes and they have been added.

Response Lines: 140-150.

Comment Line 149: Use l min-1 for consistency.

Response: Changed everywhere.

Comment Line 237-238: This is repetition of 232-233.

Response: Changed.

Response Lines: 299-300.

Comment Line 289: Write PM1–10 with subscript.

Response: Changed everywhere.

Comment Line 341: SOA already defined in line 33, so expansion is not needed here.

Response: Corrected.

Response Line: 409.

Comment Line 342: Instead of 'biogenic VOC', use BVOC as already defined.

Response: Done.

Response Line: 410.

Comment Line 460: OA has not been defined previously.

Response: This text has been removed.

Comment Line 645: SOA already defined in line 33, so expansion is not needed here.

Response: This text has now been removed altogether.

Comment Line 709: typo after reference link

Response: Changed.

Response Lines: 840-844.

Comment Line 760: Provided link is not working.

Response: Corrected.

Response Line: 891.

Comment Line 927: Link to reference has not been provided. Pls correct all the incorrect references.

Response: The link to the reference has been provided. All the incoreect references have been corrected.

Response Line: 1043.

Comment: Use subscript formatting for PM size ranges (e.g., PM_{1-10} instead of PM1-10).

Response: Changed everywhere.