RC2: Response to Comments

Major comments:

- The authors use relationships between optical properties to try and identify aerosol types and composition. They could take advantage of long-term composition data near these sites from the IMPROVE and CSN networks. These data have been reported in Hand et al (2024, https://doi.org/10.1029/2024JD042579) and may help place the results of this paper into the context of what has been reported for the aerosol composition in this same region and to discuss whether their results appear consistent with measured composition.
This is a great suggestion. Given that none of the IMPROVE or CSN sites are directly collocated spatially with the SPL and BOS measurement sites and that the temporal resolution is different (hourly and continuous for the SPL and BOS measurements vs 24h every 3 days for IMPROVE), we chose not to pull the data from those networks into this analysis. But the reviewer is correct that Hand et al. (2024) is a great study that could be used to contextualize this optical analysis.

   That said, Hand et. al. (2024a) shows for the 2019-2022 time period the Central Rockies (where SPL is located) are dominated by dust in the spring months while organics dominate the summer and early fall (June-October), which they partly attribute to wildfires (their Fig. 6). In contrast, the Colorado Front Range (where BOS is located) is less impacted by dust in the spring and organics are highest in August and September. Hand et al. (2024b) look at mean trends in individual aerosol types over 2000-2021. They show a positive trend in summer and fall organic mass concentrations in Colorado that they attribute in part to wildfires (their Fig. 9) although the overall mean trend for the SW region is negative for all seasons (their Fig. 10). They show no or negative mean trends in dust for Colorado and the SW region for winter and spring (their Figures 13 and 14). This is generally consistent with our quantile regression figure that only shows trends at the extremes, but not for the median. The trends cannot be directly compared because different years were considered and different methods used.

   The following references have been added to the text:
   Line 285: "This is consistent with positive trends in organic mass concentration in Colorado that have been previously attributed to wildfires (Hand et al., 2024b)"

   Line 315: "The influence of these dust sources is also confirmed by chemical data from the region presented by Hand et al. (2024). "

   Hand, J. L., Prenni, A. J., Raffuse, S. M., Hyslop, N. P., Malm, W. C., & Schichtel, B. A.: Spatial and seasonal variability of remote and urban speciated fine particulate matter in the United States. *Journal of Geophysical Research: Atmospheres*, 129, e2024JD042579, https://doi.org/10.1029/2024JD042579, 2024a.

   Hand, J. L., Prenni, A. J., & Schichtel, B. A.: Trends in seasonal mean speciated aerosol composition in remote areas of the United States from 2000 through 2021. *Journal of Geophysical Research: Atmospheres*, 129, e2023JD039902.

https://doi.org/10.1029/2023JD039902, 2024b.

- Have the authors compared size-related optical properties to each other? For example, the ratio of scattering a 1 um to 10 um compared to SAE? Or BFR

  We did briefly evaluate the differences between PM1 vs PM10. The scattering and absorption sub-micron fractions were discussed in lines 176 - 180, and their monthly medians were shown in Fig S2. We also show the sub-micron values for SAE and BFR in Fig. S9 & S10. These values and figures are all referenced throughout the discussion of the main text.

  However, if the reviewer is commenting on a comparison between sub-micron fraction and overall SAE/ BFR then no, that was not initially done in this work. The analysis could be added to the supplemental, but we do not think it would add substantially to this work. In the interest of completeness, we did the same comparisons presented in Fig. 6 & S12 - binning the SAE and BFR by the Rsp monthly with each point representing 100 hourly data points (see figures below). For SAE at both sites, the lowest values / increased particle size tend towards the lowest Rsp values / decreased sub-micron contribution. The BFR to Rsp relationship is similar, showing that when there is a shift to larger particles (lower BFR) the Rsp / sub-micron contribution also decreases though the relationship is not as strong given that BFR is more sensitive to changes in accumulation mode aerosols. The top row of Fig RC3 is consistent with previous work done by Li & Ginoux (2025), who saw similar relationships in the SAE and sub-micron fraction for 8 NFAN sites (labeled AE and FMF in their Fig. 3), and Delene & Ogren (2002), who showed similar Rsp to SAE relationships for other surface in-situ sites.

  Li, X., & Ginoux, P.: An empirical parameterization to separate coarse and fine mode aerosol optical depth over land. Geophysical Research Letters, 52, e2024GL114397. https://doi.org/10.1029/2024GL114397, 2025.

  Delene, D. J., & Ogren, J.A.: Variability of Aerosol Optical Properties at Four North American Surface Monitoring Sites. J. Atmos. Sci., 59, 1135–1150, https://doi.org/10.1175/1520-0469(2002)059<1135:VOAOPA>2.0.CO;2, 2002.

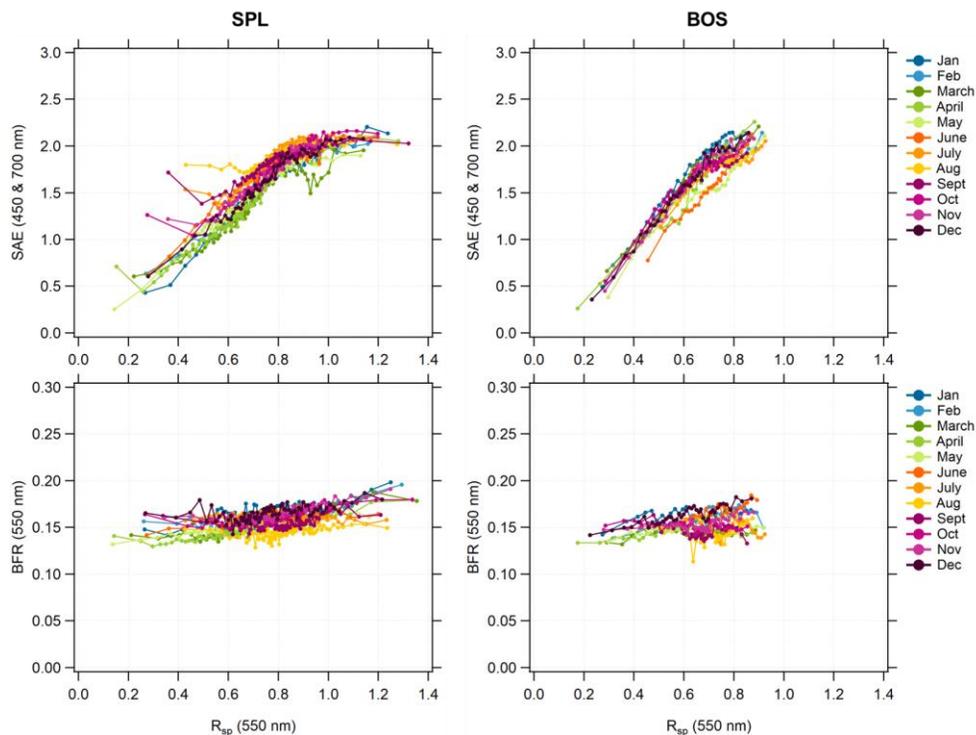**Fig RC3:** PM$_{10}$ SAE (450 & 700 nm) binned by R$_{sp}$ (550 nm) for (a) SPL and (b) BOS. PM$_{10}$ BFR (550 nm) binned by the BFR (550 nm) for (c) SPL and (d) BOS. For all plots, each data point represents the median of 100 data points. Traces are colored by month.

- "Data" are commonly referred to in the plural within scientific literature, but there are many instances in this paper where it is referred to as the singular. Consider using the plural consistently.

  Thank you for the comment, a conscious effort has been made to remove and correct the instances of this in the text. If there are any notable instances in the revised text please let us know.

- When referring to trends, it is helpful to refer to a trend as "negative" (or "positive") rather than "decreasing" (or "increasing") because the trend itself is a rate. For example, for decreasing light scattering, the trend is negative. Consider replacing these instances in the text.

  We have changed the terminology in the section on trends to use negative / positive instead of increasing / decreasing.

- Organizational comment: It might be useful to reorganize the paper so that the trend analysis comes at the end. In this way the reader can contextualize the patterns observed in the data to how they have changed over time.

  We thank the reviewer for this feedback. Reviewer #1 also had this comment and we agree that a slight restructuring would be helpful. We propose the following new structure:

The new text will be re-structured with this outline.

- Figures: It would help to increase the font on the axis labels. It's difficult to see the difference between the subscripts for "sp" and "ap" for scattering and absorption, respectively.
  We can absolutely increase the axis and legend labels to improve visibility, thank you for the comment.

Line / Minor Comments:

- Line 75: The Storm Peak Laboratory and Table Mountain Field Site acronyms have been previously introduced and so could be used here.
  Line 75: We elected to use the full name in this instance since it's the first reference to the sites in the methods section.

- Line 79: Define GAW
  Done

- Line 104: Aerodynamic diameter is usually greater than physical diameter (Dp ~ Dae*SQRT((Chi/rho_p)), where Dp is physical diameter, Dae is aerodynamic diameter, Chi is shape factor, and rho_p is particle density.
  Line 104: This was not meant to denote physical vs aerodynamic diameter. This was a statement of manufacturer specification vs aerodynamic cut diameter for sampling in our system. An additional citation has been added to better reference performance testing, and the text has been edited to read:

  "A switched impactor system provides size-segregated measurements using Berner-type multijet cascade impactors for 10 μm and 1 μm size cuts, which have aerodynamic cut diameters of ~7 μm and ~0.7 μm under our sampling system (Berner et al., 1979; Hillamo and Kauppinen, 1991)."

- Line 111: Acronyms for light scattering and backscattering have been introduced and can be substituted here.
  Line 111: The mention of these has been changed to "σ_{sp} and σ_{bsp}".

- Line 115: What are the uncertainties in scattering and absorption?
  Line 115: Generally total uncertainty in scattering from the TSI 3760 Nephelometer is ~9.2%, and for absorption from the CLAP is ~20% for a 1-hr averaging time for typical continental conditions. The following statements and references have been added to the instrumentation section to indicate this:

  Line 120: "The overall uncertainty in the nephelometer measurements has previously been evaluated to be ~9.2% for σ_{sp} and ~8.9% for σ_{bsp} (Sherman et al., 2015)."
  Line 135: "Uncertainty in the CLAP σ_{ap} measurement is ~20% (Ogren et al., 2017; Sherman et al., 2015)"

- Line 138: Change "wavelength" to "wavelengths"
  Done

- Line 139: Was this filtering also applied to analyses of light scattering and absorption, or only for calculated properties? Uncertainties in these calculated values could be calculated by propagating uncertainties in scattering and absorption. It would be helpful to provide these uncertainties, especially given the map of aerosol types shown later.
  This filtering was only applied to the calculated parameters. Following previous established methods for error propagation (Sherman et. al., 2015), we have calculated the typical fractional uncertainties for hourly averaged data when PM_{10} $\sigma_{sp} = 50$ Mm^{-1} and when $\sigma_{sp} = 1$ Mm^{-1}. These are provided below in Table RC1. We chose those two values to represent average uncertainties for extreme/outlier events and for very clean conditions that we used as the filtering cut offs. Note these are the averages for SPL and BOS - the uncertainties are slightly different for both sites as they depend on things like measurement temperature and pressure, and the correlations between various optical parameters. More details are in the supplemental materials of Sherman et al. (2015).

  We have added the following statements to the text to indicate this:
  Line 152: "Below those values the calculated parameters are more heavily influenced by instrument noise and are less reliable. Average fractional uncertainties for SSA, BFR, SAE, and AAE at these σ_{sp} and σ_{ap} constraints are 3.5%, 8.2%, 6.3% and 32.2% respectively."
  Fig 7 caption: "Average fractional uncertainties for AAE and SAE at these levels are approximately 10% and 2.9% respectively."

  We are also happy to add Table RC1 to the supplemental under Section S2: Description of auxiliary data treatment and calculations.

  Table RC1. Uncertainties of measured and calculated as a function of loading

	σ_{sp}	σ_{ap}	SAE	BFR	SSA	AAE	Rsp	Rap
$\sigma_{sp} = 50$ Mm^{-1}	9.2%	20%	2.9%	2.3%	1.0%	10%	2.8%	5.9%
$\sigma_{sp} = 1$ Mm^{-1}	10%	40%	6.3%	8.2%	3.5%	32.2%	3.1%	30%

  Sherman, J. P., Sheridan, P. J., Ogren, J. A., Andrews, E., Hageman, D., Schmeisser, L., Jefferson, A., and Sharma, S.: A multi-year study of lower tropospheric aerosol variability and systematic relationships from four North American regions, Atmos. Chem. Phys., 15, 12487–12517, https://doi.org/10.5194/acp-15-12487-2015, 2015.

- Line 170: What completeness criteria did the authors apply to calculate the parameters used in the trends? As well as in the climatological properties?
  In terms of both the climatology and the trend analysis we tried to ensure that there was enough data coverage in each season and month for the analysis to be considered representative. For both the σ_{sp}

and the SAE at SPL, we have ≥50% hourly data coverage in every season and month even after filtering was applied to the calculated variables. There is similar average monthly coverage for σ_{ap} and BFR, however, coverage is low for SSA and AAE. Coverage for σ_{ap} is lower than that for σ_{sp} because the measurement is filter based, and at remote sites the filter does not always get changed right away. The percent coverage of hourly data for all of these variables is summarized in Table RC2 below. For the calculated variables, we confirmed that the overall 25th, 50th, and 75th percentiles did not change significantly as a result of the filtering (Table S2). Taking this further for the SSA and AAE, since these variables had the lowest coverage, it can be seen that a similar climatology is shown in both the filtered and unfiltered data even with the low data coverage (**Fig RC4**). Altogether, this gives us confidence that the measurements are representative of conditions at the two sites.

Table RC2: Average seasonal and monthly percent coverage of hourly data for σ_{sp} and σ_{ap}, as well as the calculated parameters, SSA, BFR, SAE, and AAE, after quality control filtering was applied.

	Winter	Spring	Summer	Fall
σ_{sp}	86.9	91.8	83.9	80.2
SAE	59.4	81.7	83.0	72.7

| **SPL**	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
σ_{sp}	85.8	91.9	91.9	87.6	96.0	90.4	78.3	82.9	85.4	77.0	78.3	83.3
σ_{ap}	75.6	85.6	84.0	76.4	64.7	62.6	65.2	66.0	76.2	68.4	70.6	72.7
SSA	10.4	21.4	35.7	39.2	35.9	44.9	50.4	51.4	50.4	32.9	19.3	11.4
BFR	63.2	81.3	82.8	80.3	89.5	89.5	78.1	82.7	83.8	72.0	70.7	65.5
SAE	50.5	73.8	79.0	78.3	87.7	88.8	77.7	82.4	83.1	69.5	65.6	54.4
AAE	5.3	11.3	23.1	27.4	23.5	37.4	46.4	47.4	40.8	23.0	9.7	6.0
BOS	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
σ_{sp}	94.0	99.8	96.8	91.5	97.4	90.6	93.4	97.9	99.8	97.2	98.8	95.8
σ_{ap}	86.7	98.9	94.1	91.4	96.6	90.1	93.2	95.6	96.5	93.3	94.8	91.7
SSA	60.4	69.3	69.4	70.7	77.3	77.0	88.0	87.6	89.0	78.3	74.6	59.5
BFR	92.1	98.9	95.5	90.9	96.7	90.6	93.5	97.9	99.4	96.4	98.1	91.4
SAE	89.2	96.2	94.4	90.6	96.2	90.2	93.3	97.9	99.4	96.5	95.5	87.6
AAE	64.1	60.7	66.0	65.0	75.7	79.1	89.2	91.6	89.8	79.3	69.2	57.3
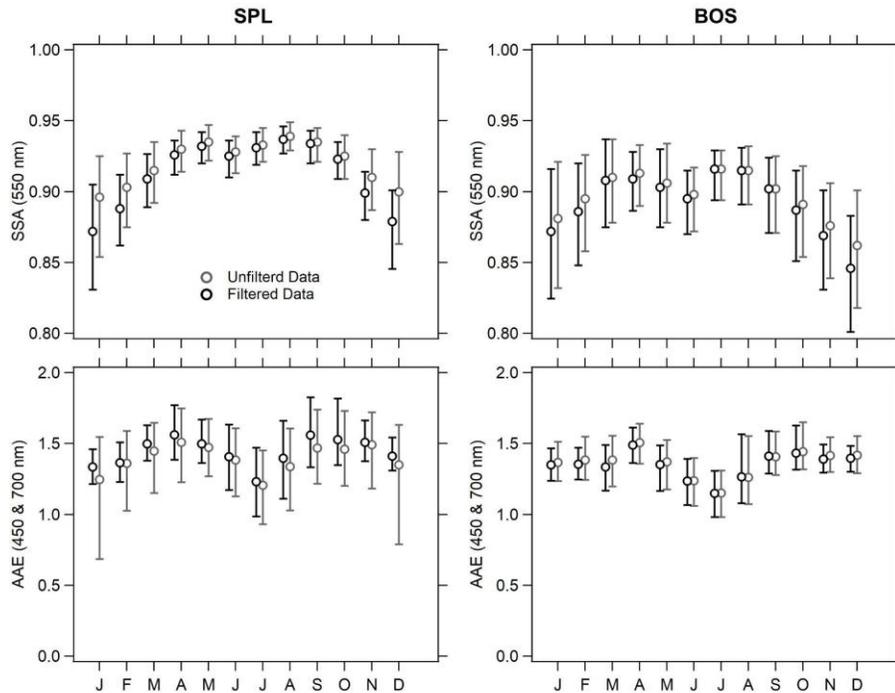
Fig RC4: Monthly 25th, 50th (median), and 75th percentiles for the SSA (550 nm) and AAE (450 & 700 nm) at SPL (left) and BOS (right). Grey markers include all measurements, while black markers show statistical values after filtering was applied based on total scattering and absorption.

- Line 173-174: Explicitly mention what is shown in Figure 2 and 3 (rather than group them together in the text).
  Line 186: The following statement has been added to differentiate between the plots:
  "This is visible in both the timeseries of average monthly σ_{sp} and σ_{ap} values, shown in **Fig. 2**, and the annual climatology, shown in **Fig. 3**."

- Line 175: Add "respectively" after "BOS"
  Done

- Line 207: It appears contradictory that in Lines 199-200 the authors state that during the May event limited upward and westward transport to SPL occurred.

  By limited we did not mean there was no transport to SPL for the May event, rather that transport of smoke to SPL was reduced relative to BOS because the mountains acted as vertical and horizontal barriers. BOS sampled higher concentrations for a longer period of time than were sampled by SPL. The text has been changed to read:

  Line214: "...smoke being channelled down the Front Range of the Rocky Mountains with less

upward and westward transport to SPL (see 2023 BOS σ_{sp} and σ_{ap} spike in **Fig. 2**). "

- Line 220: Why isn't May included?
  This was a typo, May is included. All analysis referencing the 'spring' in this work includes measurements for March – May.

- Line 227: Presumably all the light scattering data used for these trends are for RH<40% so the impacts of RH on scattering are not influencing these trends. Did the authors investigate these trends as a function of RH even below 40%? It is important to remind the reader that these trends are for aerosol properties considered to be "dry".
  Line 227: That is correct, and trends were not investigated as a function of RH, even <40%. To give context we have provided an overall and monthly histograms using data from 01/2022 – 07/2025, of the hourly RH data form inside the nephelometer at BOS (Fig. RC5). The majority of data is below an RH of 20%, and even in the summer when RH is highest the sample RH does not get higher than 35%. The RH at SPL would be expected to be lower than that at BOS, given its lower ambient temperatures. This just doesn't leave much room to look at the trends in the context of RH. Additionally, the composition and loading changes throughout the year along with RH would make it difficult to separate changes caused by the different factors.

  Following other comments by the reviewer, reminders of the dry sampling conditions have been added at various points throughout the text and in figure captions.
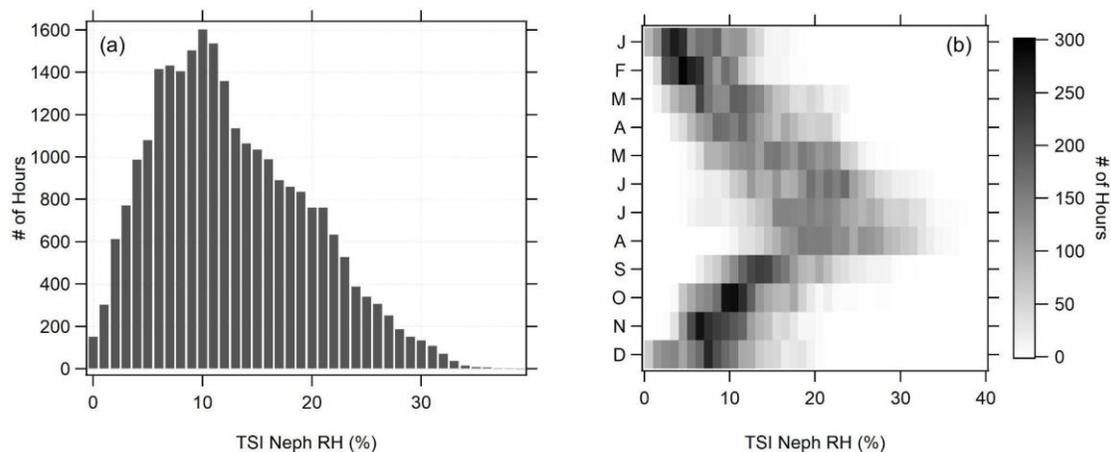

Figure RC5: (a) Total and (b) monthly distribution of hourly median measurement cell RH for the nephelometer for the 01/2022 – 07/2025 period. For all histograms shown, bin width was 1%.

- Line 237: Trends in SAE in spring are ~0. If dust has decreased, wouldn't SAE likely increase? Since winter and spring trends diverge over the 80th percentile (and presumably the increase in spring is related to dust) wouldn't you expect to see this in the SAE? Do you see this impact on other size-related parameters?
  Trends at the highest quantiles (70th and above) of SAE in the spring are ~0 and not significant. This indicates that there are not significant changes in the springtime periods that are dominated by smaller particles. Increased dust contributions would lead to lower SAE so changes in the lower percentiles of

SAE will be indicative of enhanced dust. Figure 4 in the submitted manuscript shows that the lower percentile trends in SAE (below the 80th quantile, and even more obviously below the 50th quantile) for winter, spring and fall exhibit statistically significant negative trends. These negative trends suggest an increasing contribution of coarse mode aerosol during these seasons, which is likely from decreases in concentrations of smaller background aerosols.

Looking at the scattering trends in the winter and spring above the 80th percentile, we do see a divergence. While that is likely related to dust, it's important to point out that those trends in both seasons are still negative, the ones in the spring are just less negative and veer towards zero. As we stated in the text that could indicate a slight decrease in dust intensity which would change total aerosol loading but may not lead to large changes in the SAE, since SAE is independent of concentration. Alternatively, it could be an artifact of an overall decrease in aerosol loading in the spring that would simply be less apparent in the upper quantiles when larger sources / events are adding to the total loading.

Since SAE and Rsp are the primary variables sensitive to dust and Figure RC2 indicates they are positively correlated we would expect trends in Rsp to be consistent with the SAE trend analysis.

- Line 240: Light scattering in winter is quite low (according to Figure 3). What is the uncertainty in SAE during these months? Are the trends in the lowest percentiles reliable?
  Table RC2 provides uncertainty values for all the variables for both clean conditions and the upper scattering threshold (50 Mm^{-1}) used to identify extreme events. Fractional uncertainty in SAE for during low scattering ($\sigma_{sp} \leq 1$ Mm^{-1}) is 6.3%. So even though scattering is low in the winter the values with the highest uncertainty would not be larger than that given our filtering parameters.

  That said, we feel it's important to emphasize here that the lowest SAE values are not necessarily tied to the lowest values of the light scattering coefficients and therefore the largest uncertainties. The SAE depends on the difference in scattering between the two wavelengths used in the calculation. The lowest SAE values have the smallest difference between scattering at the two wavelengths, so the lowest percentiles simply correspond to the periods with the largest particles which can be periods of high loading/ scattering.

- Line 248: "Consistent attributable" appears to be a typo.
  Yes, 'consistent' has been removed.

- Line 275: These have been defined and the acronyms could be used here.
  Line 275: "scattering Ångström exponent and backscatter fraction" have been replaced by SAE and BFR

- Line 275: and also for fall for BFR.
  Line 275: The statement concerning the late summer increase in SAE / decrease in BFR has been extended to include the fall where this relationship also occurs:
  "As BFR and SAE are sensitive to different parts of the aerosol size distribution, the higher sub-micron contribution (increased SAE) with increased large accumulation mode particles (decreased

BFR) later in the summer and fall could indicate a narrowing of the size distribution (Collaud Coen et al., 2007)."

- Line 286: The acronym could be used here.
  Line 286: "single scattering albedo " has been replaced by SSA

- Line 298: What do the authors mean by "anthropogenic biomass burning"?
  Line 298: This was poor wording, this has been changed to "... mixture of fossil fuel, biomass burning, and BC dominated aerosol particles."

- Line 303: Figure S11 shows number of hours- number of hours of what?
  Line 303 / Fig. S11: Number of average hourly periods where AAE data was available over the entire sampling period. The figure caption has been updated to make this more clear: "Histograms of hourly AAE data, with the y-axis showing a total count of the number of hourly periods (# hours), for the spring and summer periods over all years at (a, c) SPL (2011-2024) and (b, d) BOS (2019-2024). Note that the y-axis is a log scale."

- Line 323: Can the authors explain why the particles have become less absorbing but there appears to be more smoke in the later period?
  A similar comment was made by Reviewer #1, and so we give a similar comment. Biomass burning (BB) from wildfires has been shown to be more scattering overall, with higher measured mass scattering efficiencies (MSE) compared to mass absorption efficiencies (MAE) leading to higher SSA values. This was shown during the Fire Laboratory at Missoula Experiments (Levin et. al., 2010; Mack et. al., 2010), and is consistent with measured MSE and SSA for BB sources under ambient conditions (Laing et. al., 2016). It's also been shown that SSA can increase as the age/ transport time of BB plumes increase. Using flights with repeated transects of BB plumes, Kleinman et. at. (2020) showed increases in both SSA and MSE for aged wildfire smoke. Selimovic et. al (2019) also observed increases in SSA as a function of time over a prolonged period of biomass burning. With these results we do expect the SSA to be high when the sites are measuring BB sources, even with the increase in BB / BC in the summer as indicated by the AAE. So with these results we do expect there to be increases in total scattering when BB is a major source.

    Levin, E. J. T., McMeeking, G. R., Carrico, C., Mack, L., Kreidenweis, S. M., Wold, C. E., Moosmuller, H., Arnott, W. P., Hao, W. M., Collett, J. L., and Malm, W. C.:Biomass burning smoke aerosol properties measured during Fire Laboratory at Missoula Experiments (FLAME), J. Geophys. Res.-Atmos.,115, doi:10.1029/2009JD013601, 2010.

    Laing, J. R., Jaffe, D. A., and Hee, J. R.: Physical and optical properties of aged biomass burning aerosol from wildfires in Siberia and the Western USA at the Mt. Bachelor Observatory, Atmos. Chem. Phys., 16, 15185–15197, https://doi.org/10.5194/acp-16-15185-2016, 2016.

    Mack, L. A., Levin, E. J. T., Kreidenweis, S. M., Obrist, D., Moosmüller, H., Lewis, K. A., Arnott, W. P., McMeeking, G. R., Sullivan, A. P., Wold, C. E., Hao, W.-M., Collett Jr., J. L., and Malm, W. C.: Optical closure experiments for biomass smoke aerosols, Atmos. Chem. Phys., 10,

9017–9026, https://doi.org/10.5194/acp-10-9017-2010, 2010.

Kleinman, L. I., Sedlacek III, A. J., Adachi, K., Buseck, P. R., Collier, S., Dubey, M. K., Hodshire, A. L., Lewis, E., Onasch, T. B., Pierce, J. R., Shilling, J., Springston, S. R., Wang, J., Zhang, Q., Zhou, S., and Yokelson, R. J.: Rapid evolution of aerosol particles and their optical properties downwind of wildfires in the western US, Atmos. Chem. Phys., 20, 13319–13341, https://doi.org/10.5194/acp-20-13319-2020, 2020.

Selimovic, V., Yokelson, R. J., McMeeking, G. R., and Coefield, S.: In situ measurements of trace gases, PM, and aerosol optical properties during the 2017 NW US wildfire smoke event, Atmos. Chem. Phys., 19, 3905–3926, https://doi.org/10.5194/acp-19-3905-2019, 2019.

- Line 325: Is the SPL site influenced by residential wood combustion in Steamboat?
  SPL's mountaintop location is more isolated from anthropogenic emissions in the valley during cold months because the thermal gradients driving upslope/downslope flow are not as strong (e.g., Collaud Coen et al., 2018). Thus SPL is less likely to sample smoke related to home heating in the seasons when residential combustion is most prevalent. A more likely source of absorbing aerosol are the ski area activities (snow mobiles and snow grooming vehicles) but those data are marked as contamination during the manual editing process and not included in the data analyzed here.

  Collaud Coen, M., Andrews, E., Aliaga, D., Andrade, M., Angelov, H., Bukowiecki, N., Ealo, M., Fialho, P., Flentje, H., Hallar, A. G., Hooda, R., Kalapov, I., Krejci, R., Lin, N.-H., Marinoni, A., Ming, J., Nguyen, N. A., Pandolfi, M., Pont, V., Ries, L., Rodríguez, S., Schauer, G., Sellegri, K., Sharma, S., Sun, J., Tunved, P., Velasquez, P., and Ruffieux, D.: Identification of topographic features influencing aerosol observations at high altitude stations, Atmos. Chem. Phys., 18, 12289–12313, https://doi.org/10.5194/acp-18-12289-2018, 2018.

- Line 377 and associated discussions of clusters: Please include the cluster number after each mention as it's easier to find on the plot.
  Line 377: Thank you for this suggestion. Numbers have been added

- Line 381: Figure S16: This seems like a step change for all seasons. Does this make sense that BC dominates all seasons and all seasons see this change?
  Line 381: We note in the text (Line 405) that given the distribution of the data and the decreases in the BC dominated group over all seasons, that it's likely that the background aerosol for the sites is also falling into this category even though the background aerosol is not necessarily BC dominated. As we state, this classification has limitations and there's clearly not a classification for all aerosol types. So when we consider all the data, as we do in Fig. S15 & S16, then the classifications become less definitive especially since we do not have chemical data to parse what all is encompassed in that grouping.

- Line 428/9: The acronyms for scattering can be used here.
  These instances have been replaced with the scattering symbol (σ_{sp}).

Figure Caption Comments:

- Figure 2: Add "a" and "b" in the caption. Include that these data in (a) and (b) correspond to RH< 40%.
  Fig 2: Added label to caption along with the following statement on RH: "The average σsp and σap values represent dry sampling conditions (RH < 40%)."

- Figure 3: Include the years in the caption.
  Fig 3: done

- Figure 4: Provide years for trends and include RH < 40%. Here the significance is given by alpha but the rest of the text it is referred to as a p-value (like line 167).
  This has been noted in the caption, and significance has been put in terms of the p-value:
  "Quantile regression trends for PM10 (a) σsp and (b) SAE at SPL over all seasons from 2011 to 2024. Winter = Dec – Feb, Spring = March - May, Summer = June - Aug, Fall = Sept - Nov. Open markers show trends that were not significant (p-value ≥ 0.05). Numerical values and p-values for the quantile regression trends are provided in Table S5 & S6. As with other analyses presented, these trends are for dry sampling conditions (RH < 40%)."

- Figure 1: Change S14 to S12.
  There is no reference to Fig S14 in Fig 1 or Fig S1. We request clarification on this comment before making changes.

- Figure S7: Include the location in the caption.
  Fig S7: done

- Figure S8: Include (a), (b), etc in the caption. What is the difference between a-b and c-d?
  Fig S8: Apologies for not including this distinction originally. Panels (a) & (b) show data for the entire Rocky Mountain Area – including Colorado, Kansas, Nebraska, South Dakota, and Wyoming – while (c) & (d) show data only for Colorado. This has been added to the caption.

- Figure S11: Captions states "histogram" but axis reads "# of hours" ?
  Fig S11: Yes, the distribution is not normalized in any way so the axis is just a total count of the hourly averaged periods in the spring and summer periods over the entire date range (2011 - 2024 for SPL and 2019 - 2024 for BOS) where AAE was in each bin range.

  To make this more clear the caption has been changed to: "Histograms of hourly AAE data, with the y-axis showing a total count of the number of hourly periods (# hours), for the spring and summer periods over all years with measurements at (a, c) SPL (2011-2024) and (b, d) BOS (2019-2024). Note that the y-axis is a log scale."