Review Kau et al., 2025

Light-absorbing snow impurities: Nine years (2016-2024) of snowpack sampling close to Sonnblick Observatory, Austrian Alps

Kau et al. analyze water-insoluble organic carbon and elemental carbon in snow samples collected from the eastern Alps, near the Sonnblick Observatory, between 2016 and 2024. This study emphasizes the interference caused by dust during thermal optical analysis (TOA), which can lead to a significant underestimation of elemental carbon (EC). The authors introduce a laser correction method that offers two main advantages: it enables a more accurate quantification of EC and facilitates the detection and estimation of dust concentration. The detection of dust aligns with its presence identified through pH and calcium measurements. Additionally, although gravimetric analysis can quantify dust for a limited number of samples, it supports the dust estimation derived from the TOA approach.

The main limitation of the present manuscript is the lack in explanation about the procedure employed for TOA correction. This makes it difficult for the redear to replicate the same approach. I recommend the manuscript for publication in ACP after major revisions.

Main comments

Section 2.2.1 How do you think the non-homogeneous distribution of the LAPs on the filter affects the quantification of OC and EC? In particular, are you able to estimate the related uncertainty?

Line 128-136. It would benefit readers if the authors could provide more details about the procedure used to detect the dust layer based on TOA. For instance, does '4' refer to the change in transmittance during the cooling phase from 700 to 450 °C? If so, it would be clearer to denote it as delta ATN (also in Figure 1). The statement “Since the temperature range previously mentioned was not always reached for our set of samples” suggests that a different thermal procedure was used in prior analyses. Additionally, please clarify why the color change observed during the cooling phase indicates the presence of mineral dust.

Line 172. The authors should specify whether the “Laser/Temp Correction Method in the Calc453” refers to the default correction, which does not account for changes in transmittance with temperature due to the presence of dust. Is this the same as the “default method” indicated in Figure 2? Moreover, it would be helpful if the authors could elaborate on the correction based on the linear fit in the methods section, as this information is crucial for ensuring the replicability of the approach.

Line 189. Please explain why this method can only be applied to samples where the optical signal is predominantly influenced by dust, and how this can be inferred. While you can estimate dust presence through calcium measurements or pH data, this does not provide information on the content of elemental carbon (EC) and the relative contributions of these two components to the optical properties of the sample. Additionally, if dust is negligible, I assume that applying the linear fit correction would not result in any significant changes to the results, as illustrated in Figure 2. Is this assumption correct?

Line 260-265: The differing behavior of the snowpack with mineral dust (MD) and the lowest snowpack layers shown in Figure 4 suggests that MD from various sources exhibits distinct optical responses. Is this due to the fact that optical properties are not solely determined by iron content? Could the authors elaborate on this point further? Would the authors recommend validating the linear fit method with field measurements to ensure its applicability in different environments or regions?

Fig 5. Presenting the statistical distribution of eight measurements using a box-whisker plot can be misleading, as this plot summarizes a dataset consisting of only eight data points with just six numbers. I would suggest simply reporting the median and providing the range in brackets within the text.

Page 15 discusses previous studies that recommended quantitatively measuring dust using polycarbonate filters (Kuchiki etal., 2015). Why did the authors choose not to pursue this method? Did they plan to use the same filter for both gravimetric measurements and thermal optical analysis? Furthermore, does the comparison between thermal optical analysis (TOA) and gravimetric dust quantification suggest that the TOA approach should be applied to all reddish filters, and should the defined threshold for triggering measurements be modified?

In the conclusions section, while summarizing the study's results, the authors should also emphasize the caveats and limitations of the described method, as well as the implications of their findings, as outlined in the author guidelines (https://www.atmospheric-chemistry-and-physics.net/policies/guidelines_for_authors.html).

Technical corrections

Line 44. Please add references to support this sentence:" and is commonly applied to filters loaded with insoluble particles from snow samples."

Line 46. "A comprehensive discussion of the impact of this bias on elemental carbon results in seasonal snow covers is still lacking." This sentence is correct when referring specifically to thermal optical method. I suggest revising this sentence to clarify it refers to one specific measurement technique.

Pag9. I suggest reporting the concertation of OC and EC from previous studies in a table. This would make it easier for the reader to compare the previous results with the ones reported in this work.

Line 296-297: please define uncertainty units

Line 299. Please specify that the indicated size range refers to dust particles in snow (that might have been subject to deposition post-processing). In facto atmospheric dust particles show a smaller diameter range (SCHWlKOWSKI et al., 1998).

References

Kuchiki, Katsuyuki, Teruo Aoki, Masashi Niwano, Sumito Matoba, Yuji Kodama, and Kouji Adachi. "Elemental carbon, organic carbon, and dust concentrations in snow measured with thermal optical and gravimetric methods: Variations during the 2007–2013 winters at Sapporo, Japan." Journal of Geophysical Research: Atmospheres 120, no. 2 (2015): 868-882.

Schwikowski, M., Seibert, P., Baltensperger, U. and Gaggeler, H.W., 1995. A study of an outstanding Saharan dust event at the high-alpine site Jungfraujoch, Switzerland. Atmospheric Environment, 29(15), pp.1829-1842.