Replies to Referee #3

We would like to sincerely thank the Referee for their careful reading of our manuscript and for their constructive and helpful comments. Their suggestions have helped us to significantly improve the clarity, structure, and scientific depth of the paper. In the revised version, we have addressed all comments point by point. Changes in the text are clearly marked in the manuscript *with red fonts*.
Below, we provide detailed responses (*red fonts*) to each reviewer's comment (*black fonts*) and indicate where the corresponding revisions have been implemented.

General comments:

The authors in the present study investigated the vertical profiles of pollen grains with a multi-channel elastic-fluorescence lidar and evaluated their findings in relation to the results obtained from real-time devices like Poleno and WIBS as well as to Hirst sampler. In addition, particulate matter originating from the Canadian and German megafires were detected in the atmosphere.

The manuscript is within the aims and scope of ACP. The overall study is well designed and the results clearly presented. The manuscript is well-organized and written. Some typos have been highlighted in the text. Comments regarding specific issues are included in the manuscript.

My recommendation is to be accepted for publication after the authors address all comments.

We sincerely thank the Referee for the careful reading and the constructive comments, which helped us clarify several important points regarding the interpretation of biological particle detection, the comparison of the Hirst and SwisensPoleno instruments, and the biochemical discussion of the fluorescence channels. All comments have been addressed in the revised manuscript, as detailed below.

Specific comments:

Comment:

How it is guarantied that biological particles are not excluded? Fungal spores for example are characterized by an extremely wide range of shapes and sizes.

Reply:

We agree and have corrected the statement. "Note that the first stage of the filter is prone to false-negative when considering fungal spores that show a greater morphological variability than pollen. "

Comment:

The reduced time resolution (a comment I do not agree with) should be compared against the limitations of the Poleno described above and the WIBS below, limitations that are not mentioned at all. Poleno excludes a large portion of bioparticles because of size and shape (see previous relevant comment) and WIBS practically confirms the biological origin of particles sized 0.5-30µm.

Reply:

Reduced time resolution is a fact: spreading of the impacting particles on the Hirst sampler band corresponds to around 2 mm which amounts to around two hours uncertainty for mere physical reasons. This has to be compared with the resolution of the timing of measurements of individual particles at the millisecond level by the Swisens Poleno.

We however agree that comparison of instruments can be more balanced (see our reply to the comment below and the corresponding changes to the manuscript).

Comment:

Tryptophan, NAD(P)H and riboflavin are essential elements present in all organisms not just microorganisms!

Reply:

We agree and have corrected the statement to reflect this broader biological presence: “The three channels can detect different biologic fluorophores—tryptophan-containing proteins, NAD(P)H co-enzymes, and riboflavin (Kaye et al., 2005; Savage et al., 2017)—which are ubiquitous in living organisms, including microbes and pollen.” (L162–164)

We have also corrected minor typographical errors and regarding Figure 4, in the calendar, Grasses should be mentioned, and not Dactylis glomerata. With the microscope, we count all grass pollen types as “Grasses”. Similarly, it would be better to use Genus names only, as it is not possible to differentiate the pollen of the different species within these genera.

Comment:

It is not clear the reason for not detecting. Although Betula and Fagus have similar shapes the size is much different. How is it possible Poleno not to detect neither one?

Reply:

We have clarified this in the revised manuscript. “The SwisensPoleno was not able to achieve a sufficient number of precise detections for the label to be activated (Crouzy et al., 2022).” (L344-345)

In line 346, we did some corrections: Hirst sampler has undoubtedly limitations but it certainly does not perform poorly in the hourly level. Certainly, some particles may not be trapped when impacted on the adhesive but that does not mean it has a poor hourly resolution. The transverse traverses give hourly data with very good taxa representation and concentration but they are time consuming and usually avoided. On the other hand, Poleno failed to register Betulaceae and Fagaceae. The explanation given for it is inadequate. Furthermore, in previous section it is mentioned that 4 horizontal lines were measured. This way we have mean daily concentration. In Fig 5 hourly data are presented.

This paragraph was revised significantly to a more accurate comparison of the sampler’s performance. We have reformulated the paragraph in the line of the suggestions by the referee.

"The Hirst trap has a lower temporal resolution compared to the SwisensPoleno: in the operational longitudinal scanning mode used at MeteoSwiss it shows limitations at the hourly level due to limited sampling efficiency and broad band spreading. However, especially for high pollen concentrations, Hirst samplers can give a hint on the sub daily evolution of the pollen concentration. Hirst performance improves at the daily level but deviations between Hirst traps operating in parallel can still be observed (Adamov et al., 2024). Notably (Oteros et al., 2017). improper calibration of Hirst flow has been documented, which may lead to deviations reaching up to 72% These factors highlight the limitations in Hirst precision and reliability, especially for fine temporal analyses. Those limitations are currently still balanced by the more precise discrimination capabilities of Hirst measurements compared to the commercially-available automatic instruments." (L346-353).