The authors would like to thank the reviewer for his/her valuable comments and suggestions. We have modified the manuscript with the proposed changes along with step-by-step answers to the suggestions. Please note that changes have been highlighted (in bold or 'track changes') in the manuscript and the corresponding answers to the reviewer by text below. The original comments are presented in bold letters.

Reviewer #3

The authors present both active remote sensing measurements and in situ aerosol observations of birch and pine pollen particles at Vehmasmäki (Kuopio), Finland to analyze the spectral dependence of the particle depolarization ratio (PDR). A special feature of this study is that the concurrent use of three different lidar systems enables measurements of PDR at four different wavelengths. Furthermore, the measurements were conducted at a rural forest site, with typically reduced pollution in the background. This is of great value as it allows the authors to study optical properties of pure pollen which is especially important as pollen have typically low concentrations compared to other atmospheric aerosol types.

Therefore, this study is important and suitable for ACP. Overall, the paper is well written and of good quality. Only some few aspects could be explained further/expressed clearer and several typos should be corrected, which will be addressed in the special comments below.

Special comments:

ll. 60-61: Veselovskii et al. (2021) only used a single broadband fluorescence channel in this study. An approach to obtain spectral fluorescence information by several fluorescence channels has just been presented in Veselovskii et al. (2023, preprint).

Thank you for your comment. We have included the suggested study in the manuscript.

ll. 136-137: I don't understand what is meant with the statement that NS and OPS aerosol size distributions were combined, but NS size distribution was neglected. If only the OPS size distribution was used, then it wasn't combined with the NS one, was it? Could you please clarify this?

Indeed, the sentence is incomplete and misleading. Only the last two bins of the NS size distribution were neglected, not the whole size distribution. We have corrected the sentence.

ll. 206-207: The statement 'For each pollen type … of that specific pollen alone is studied' has already been stated in the same way in ll. 185-187 and is thus repetitive and could be removed.

Removed as suggested.

ll. 238-240, Fig. 4: Also, the 532 nm PDR seems similarly correlated to pollen concentration and concentration of other aerosols as the two longest wavelengths. Only the PDR at 355 nm seems less influenced. Why? Do you also relate this to the higher sensitivity of longer wavelengths to the comparably large pollen particles? Please explain your conclusion further here.

The reviewer raises a valid comment. One important factor to be considered here is the pollen distribution within the PBL and its relative share to other aerosols. Birch is a big particle (~25μm) and at the same time smaller compared to pine pollen (~75μm) and its distribution may change with height. Given the scenario that we have a well-mixed PBL with constant share of background aerosols and birch pollen then the height limitation of the PDR at 355nm should not be a problem, depicting the birch optical properties. In other times, the 800m height can be limiting enough to see the full effect of birch on the PDR_{355} when the PBL is not well-mixed or if the concentration of birch is not homogeneously distributed within PBL (well-mixed or not). In this context, the longer wavelengths do present an advantage for pollen detection as they are less influenced by the concentration/presence of smaller particles. This study contains optical properties for a wide range of birch concentrations. In fact, the higher end of birch concentrations occurred at the measurement site are exceptional and not frequent at all. Therefore, we conclude that the birch PDR at 355nm wavelength have been sensed adequately in ambient conditions. This conclusion is backed up by laboratory studies as well which found similar behaviour at 355nm compared to longer wavelengths.

Figure 6: Why do you have less PDR values at 910 nm (only 2?) for pine concentrations > 4000 m^{-3} compared to the other wavelengths? Was there a technical issue with the respective lidar? Maybe you could add a short remark on that, please.

The reviewer is correct. The CL61 ceilometer was not operational for a few days during the pine season in 2021 which resulted to fewer cases at this specific wavelength. More specifically, out of the 110 pine cases, 77 occurred during 2021 and 33 cases during 2022. Although both years had comparable pine concentrations, the low cloud conditions during most of the high pine concentration in 2022 limited the derivation of the optical properties. We have added the following sentence to the manuscript:

'Note that the CL61 instrument was not operational the full pine period and thus has lower number of cases.'

Typos and technical notes:

l. 19: ‘… is closely associated to allergic diseases’ --> is closely associated with allergic diseases.

Corrected as suggested.

l. 28: ‘SSPs’ --> ‘SPPs’

Corrected.

l. 31: ‘are an effective ice nuclei’ --> are effective ice nuclei (as it is plural)

Noted and corrected as suggested.

l. 45: ‘depolarisation’ --> depolarization

Corrected.

l. 60: ‘polarisation’ --> polarization

Corrected.

l. 82: ‘vary from year to another’ --> vary from one year to another

Corrected as suggested.

l. 103: ‘can be found at Vakkari et al. (2021)’ --> can be found in Vakkari et al. (2021)

Corrected.

l. 205: ‘Sect.2.6’ --> Sect. 2.6 (missing space)

Corrected.

l. 212, l. 213: don’t forget the point after Fig. …, e. g., ‘Fig 2a’ --> Fig. 2a

Thank you for your comment. We went through the manuscript, and we have added the missing dots.

l. 213: ‘Fig 2a)’ --> Fig. 2b) (the shaded area is found in panel b)

Corrected.

l. 222: ‘has previously seen’ --> has previously been seen

Corrected.

l. 284: ‘calculations performed’ --> calculations were performed

Corrected.

l. 328: ‘set up’ --> setup (as it is the noun)

Noted and corrected.

References:

Veselovskii, I., Kasianik, N., Korenskii, M., Hu, Q., Goloub, P., Podvin, T., and Liu, D.: Multiwavelength fluorescence lidar observations of fresh smoke plumes, Atmos. Meas. Tech. Discuss. [preprint], https://doi.org/10.5194/amt-2023-5, in review, 2023.