Response to Referee #1

For referee comment no.2 (RC3: ‘clarification’)

Thank you for carefully reading the manuscript and providing useful suggestions to improve the paper. The replies to the referee comments are given below. The referee comments are highlighted in blue, and numbering with C*n*. Our responses are in black. The sentences in the manuscript are between the quotation marks, with the modifications in the revised manuscript in red.

C1 Thank you for your quick reply to my Referee comment. I now have a better picture of what you are doing. I also believe that your presentation is unnecessarily convoluted. The manuscript should be simplified in the presentation of the method as well as with regard to the used language and parameters. For instance, it would be much easier to follow your reasoning if you were to use the Ångtröm exponent Å in your method rather than the unphysical parameters η, η', η'', and $\hat{\eta}$. I had to continuously go back and forth to remind myself what all those parameters represent. I also don’t agree with your reference to simulations, a direct model, and an indirect model. What your present is a purely analytical treatment of synthetic and measured lidar profiles.

Thank you for the suggestion. We have simplified the presentation of the method, and separated the presentation of the methodology from the presentation of the results (following suggestion C5). We add descriptions after the “direct model” and “inverse model” as following to clarify the manuscript.
The structure of revised manuscript has been changed as:
“

1 Introduction

2 Site and instruments

3 Methodology – a synthetic simulator

- 3.1 Direct model – generation of synthetic optical profiles
- 3.2 Inverse model – retrieval of depolarization ratio
- 3.3 Uncertainty study

4 Results

- 4.1 Pollen grain and intense pollination period
- 4.2 Optical properties of pollen layer
  - 4.2.1 Pollen layer
  - 4.2.2 Lidar-derived optical properties
- 4.3 Estimation of optical properties for pure pollen from lidar observations
  - 4.3.1 Pollen optical properties at 532 nm
  - 4.3.2 Pollen optical properties at 1064 nm and 355 nm

5 Summary and conclusions
”

However, we use the parameter η (a function of Ångtröm exponent) because this parameter and the pollen backscatter contribution have a linear relationship. As there is a power law relationship between the Ångtröm exponent and the pollen backscatter contribution, introducing the parameter η simplifies the calculation.
This was not clearly stated in the manuscript and is improved in the revised version of the manuscript. The related equation is added in the revised manuscript and detailed calculations are added in the supplement. The methodology section is modified to make it easier to follow. In the revised version we include a Table (Table 2) to clearly present the parameters η. We only keep 2 parameters η, η' in the revised manuscript, because η''(in the original version) is equal to $1/\eta$, so $\frac{1}{\eta}$ is used for the description of depolarization ratio at 355 nm.

So in the section 3.1 of revised version, we have:

"

Pollen backscatter contribution, denoted as χ_{pollen} (Eq.4), is defined as the ratio of pollen backscatter coefficient (β_{pollen}) and the total particle backscatter coefficient (β_{particle}). Note that the use of "particle" here is to distinguish from "molecular".

$$\chi_{\text{pollen}}(\lambda, z) = \frac{\beta_{\text{pollen}}(\lambda,z)}{\beta_{\text{particle}}(\lambda,z)} \tag{4}$$

We investigate here the relationship of the backscatter-related Ångström exponent of total particles ($\text{Å}_{\text{particle}}$) and pollen backscatter contribution (χ_{pollen}) at different wavelengths (the detailed calculation is given in the supplement), resulting a power law relationship:

$$\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{particle}}(\lambda_1,\lambda_2)} = \left(\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{pollen}}(\lambda_1,\lambda_2)} - \frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)}\right)\chi_{\text{pollen}}(\lambda_2) + \frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)} \tag{5}$$

The wavelength pairs (λ_1, λ_2) are selected as (355,532), (532,355), or (1064,532) in this study. In order to simplify the calculation, we introduce two parameters η, and η′ as a function of the backscatter-related Ångström exponent between 355 and 532 nm or between 532 and 1064 nm, for the total particle backscatter coefficients:

$$\begin{cases} \eta = \left(\frac{355}{532}\right)^{-\text{Å}_{\text{particle}}(355,532)} \\ \eta' = \left(\frac{1064}{532}\right)^{-\text{Å}_{\text{particle}}(1064,532)} \end{cases} \tag{6}$$

The pairs of parameter η or η′ and χ_{pollen} at different wavelengths resulting linear relationships are reported in Table 2. For example, the pollen backscatter contribution at 532 nm ($\chi_{\text{pollen}}(532)$) is inversely proportional to the parameter η. Using the previous 6 simulated cases, a perfect linear relationship is found to fit the η versus $\chi_{\text{pollen}}(532)$ (Fig.2).

Table 2. The pairs of the parameter η($\text{Å}_{\text{particle}}$) and χ_{pollen} at different wavelengths resulting linear relationships are reported.

Wavelength pair(λ_1, λ_2) [nm]	Pollen backscatter contribution at λ_2	Backscatter-related Ångström exponent $\text{Å}(\lambda_1, \lambda_2)$	Parameter of $\text{Å}(\lambda_1, \lambda_2)$, linearly correlating with χ_{pollen}	Formulate
λ_1=355 λ_2=532	$\chi_{\text{pollen}}(532)$	$\text{Å}_{\text{particle}}(355,532)$	η	$\eta = \left(\frac{355}{532}\right)^{-\text{Å}_{\text{particle}}(355,532)}$
λ_1=532 λ_2=355	$\chi_{\text{pollen}}(355)$	$\text{Å}_{\text{particle}}(532,355)$	$\frac{1}{\eta}$	$\frac{1}{\eta} = \left(\frac{532}{355}\right)^{-\text{Å}_{\text{particle}}(355,532)}$
λ_1=1064 λ_2=532	$\chi_{\text{pollen}}(532)$	$\text{Å}_{\text{particle}}(1064,532)$	η′	$\eta' = \left(\frac{1064}{532}\right)^{-\text{Å}_{\text{particle}}(532,1064)}$

"

In the section 3.2 of revised version, we modified as:

"

The only remaining unknown to solve the Eq.7 is the depolarization ratio for pure pollen (δ_{pollen}). Next we use previously simulated β_{particle} and δ_{particle}, and the assumed $\delta_{\text{background}}$. From now on, 532 nm will be the default wavelength (if not otherwise specified). The wavelength pair (λ_1, λ_2) is selected as (355,532) in this section. Mean values of optical properties inside the pollen layer are considered in this study; it is also possible to use values of each bin of the synthetic profile which will lead to the same conclusion. Mean values of backscatter-related Ångström exponent between 355 and 532 nm inside the pollen layer, denoted as Å(355,532), can be easily retrieved.

"

In the section 4.3.2 of revised version, for study at 1064 nm, we modified as:

"

Similar study was performed to investigate the relationship between backscatter-related Ångström exponent between 532 and 1064 nm (Å(1064,532)) and pollen backscatter contribution at 532 nm, here we use another parameter η' (Eq.6), which is a function of Å(1064,532), for the total particle backscattering. From the earlier simulations, we found out that the pollen backscatter contribution at 532 nm ($\chi_{\mathrm{pollen}}(532)$) is proportional to the parameter η', considering the Eq.5 using the wavelength pair of λ_1=1064 and λ_2=532.

"

In the section 4.3.2 of revised version, for study at 355 nm, we modified as:

"

The inverse model was applied here for the backscatter-related Ångstróm exponent between 355 and 532 nm (Å(532,355)) and pollen backscatter contribution at 355 nm, using a third parameter $\frac{1}{\eta}$ (as in Eq.6, a function of Å(532,355)), which is proportional to the pollen backscatter contribution at 355 nm, considering the Eq.5 using the wavelength pair of λ_1=532 and λ_2=355.

"

Here is a description of your method as I understand it:

You are defining a set of synthetic lidar profiled for pollen and background aerosol using the set profile shape and the parameters in Table 3. These profiles are then combined to obtain a profile for the mixture of the two. You use Eq. (S5), which is the same as Eq. (13) in Tesche et al. (2009), to get the particle linear depolarisation ratio of the mixture. Your Eq. (S5) is transformed to Eq. (6) / Eq. (14) in Tesche et al. (2009) by substituting $\boldsymbol{\beta_{pollen} = \beta_{total} - \beta_{background}}$. You now have full knowledge of the system and can calculate the pollen ratio $\boldsymbol{\chi = \beta_{pollen}/\beta_{total}}$. Finally, you show that the relationship between Å and $\boldsymbol{\chi}$ can also be analytically described to find the value of Å related to $\boldsymbol{\chi = 1}$. Per definition in Table 3, Å is zero for $\boldsymbol{\chi = 1}$ in your synthetic data.

Comments:

C2 • I understand that your choice of parameters in Table 3 is not critical for presenting the overall approach. Nevertheless, it would be nice to get an idea of why those specific values have been selected. In particular, I find the background Ångtröm exponent of 3 quite large.

• Note that I am using the Ångtröm exponent in my description as I find it much easier to follow the steps using a parameter that bears physical meaning.

You are right, the choice of parameters in Table 3 (Table 1 in the revised version) is not critical for presenting the method. There are descriptions on the choices of parameters in the 1st paragraph in section 3.3.1 of the old version of manuscript. We have made some modifications in the revised version to make it more clear.
We have also changed the assumption value for non-pollen particle Ångtröm exponent as 2 (instead of 3) in the revised version. This value of 2 is more realistic. Thank you for pointing this out.

We add information in section 3.1 as:

"

The values are based on our lidar measurements (Bohlmann et al., 2019) or literature (e.g. Illingworth et al., 2015). The *background* here refers to non-depolarizing background aerosols (non-pollen particles), which can be polluted continental or biomass burning aerosols. The depolarization ratio at both 355 and 532 nm of non-pollen particle ($\delta_{\mathrm{background}}$) are selected as 0.03, which is a mean value for pollen-free periods at our measurement site. Bohlmann et al. (2019) shows that the pollen can generate strong depolarization, thus the depolarization ratio at 532 nm of pure pollen particle (δ_{pollen}) are selected as 0.35 as the initial value for the simulation in this section. Pollen grains are quite big and thus can be assumed to be wavelength independent on the backscatter at wavelengths of 355 nm and 532 nm, with the backscatter-related Ångström exponent ($\text{Å}_{\mathrm{pollen}}$) of 0. The backscatter-related

Ångström exponent between 355 and 532 nm of non-pollen particle ($Å_{\text{background}}$) is assumed to be 2, regarding the previous studies over Arctic regions (e.g. Schmeisser et al., 2018; Tomasi et al., 2012).

"

We have also modified in the first paragraph of section 3.1 as:

"

The optical and physical parameters used in the direct calculation are presented in Table 1; these parameters are named as "initial values" for the simulation.

…

In addition, the conclusion of the simulation section is not depended on the assumed profile shape or height; and the initial values are not critical for presenting the overall approach.

"

C3 • You probably don't even need to include the vertical integration of χ(z). If you use the profile of χ(z) from your synthetic data, they will still line up perfectly. In the application to real-life measurements, you might also want to leave out the vertical integral as this would require initial knowledge of the pollen layer extend in the measurements. I have a feeling that values of χ(z) outside the pollen layer will be easy to recognise and screen out in the display of Å over χ.

We agree, and change the equation as Eq.4 in our reply to the comment C1. We also add description on this in section 3.2 of revised version as:

"

Mean values of optical properties inside the pollen layer are considered in this study; it is also possible to use values of each bin of synthetic profile which will lead to the same conclusion.

"

For synthetic simulation it is the same, but for a real measurement, the use of pollen layer is preferable. We decide to keep the use of the mean values of pollen layer in this study, because it can increase the signal to noise ratio (SNR), and also eliminate the impact of other possible lofted aerosol.

Next steps in the methodology:

C4 Now that you know everything about your model aerosol, you basically turn around and use the same set of equations in the other direction with δ_{pollen} as the unknown parameter. I would expect an inverse model to be completely independent from the earlier calculations. Instead, your just re-shuffle the equations used before, vary the input value of δ_{pollen}, and iterate until you have found the value of δ_{pollen} for which Å = 0 at χ = 1. It's as simple as that but it took me quite a while to get there based on your description. I'd therefore encourage you to simplify the presentation of your methodology.

Thank you for the suggestion. We have simplified the presentation of methodology. In the section 3.2 of revised version, we changed the flow chart as following and modified the text as:

"

Mathematically, the depolarization ratio for pure pollen can be calculated using Eqs.4,5,7, as other variables are known or can be assumed. Nevertheless, we developed a retrieval method for this inverse model, so that it can be easier applied to the real lidar measurements, especially for investigating the depolarization ratio with different values of the unknown $Å_{\text{pollen}}$. An iterate approach is used. In the first step, the depolarization ratio for pure pollen was assumed to be several different values (within the range between 0.03 to 1), denoted as δ_x, in the simulator. Related pollen backscatter contribution ($\chi_{\text{pollen}}(532)$) inside the pollen layer, can be retrieved using Eqs.4 and 7. As its value depends on the assumed pollen depolarization ratio (δ_x), it can be expressed as $\chi_{\text{pollen}}(\delta_x, 532)$.

The relationship of Å(355,532) and $\chi_{\text{pollen}}(\delta_x, 532)$ was investigated using the parameter η (Eqs.5 and 6. Examples of scatter plots using mean values of η and $\chi_{\text{pollen}}(\delta_x, 532)$ in the pollen layer for cases under the assumptions of δ_x =0.1, 0.2, 0.3, 0.4 and 0.5 are shown in Fig.3. For these relationships, perfect linear fits (linear regression relationship) can be found and plotted as dotted lines in the Fig.3, following the simplified equation from Eqs.5 and 6:

$$\eta(\chi_{\text{pollen}}(\delta_x, 532)) = a_1 \cdot \chi_{\text{pollen}}(\delta_x, 532) + a_0 \qquad (8)$$

The fitting coefficient (a_1, a_0) values to determine the estimated parameter η are defined as in Eq.5. Until this step of the inverse model, no assumption on the Å_{pollen} was made, thus a_1 varies for different assumed values of δ_x. But a_0 is constant as the $\text{Å}_{\text{background}}$ is known. Theoretically, for each linear fit equation, $\chi_{\text{pollen}}(\delta_x, 532)$ values can range from 0 to 1, with 0 meaning no pollen and 1 meaning 100 % pollen in the observed aerosol particle population. Therefore, for each assumed δ_x, the η value for $\chi_{\text{pollen}}(\delta_x, 532)$=1 can be defined as the value for the pure pollen, and denote as $\eta_{\text{pure}}(\delta_x, 532)$.

In Sect. 3.1, the initial value of the backscatter-related Ångström exponent between 355 and 532 nm of pure pollen (denoted as Å_{pollen}) is 0, which results in an initial value of 1 for the parameter η. In this simulation, we assumed that the same value ($\widehat{\text{Å}}_{\text{pollen}}$=0) should be retrieved; the goal was thus to find the value of 1 for η_{pure}. From previous results shown in Fig.3, we can see a δ_x between 0.3 to 0.4 may result in a η_{pure}=1 (the black triangle in Fig.3).

Hence, in the second step, more δ_x values between that range (0.3 – 0.4) were used in the simulation, and one can retrieve the relative value of $\eta_{\text{pure}}(\delta_x, 532)$ for each case. These values are presented in Fig.4. The relationship between δ_x and $\eta_{\text{pure}}(\delta_x, 532)$ is not perfectly linear, but for these data inside the considered range, a good linear fit can be found with high correlation coefficients ~-1. As there is noise in real lidar measured profiles, two or more values of δ_x may be found as good solutions. However, after we introduce this additional second linear fit, only one solution will be retrieved in the end.

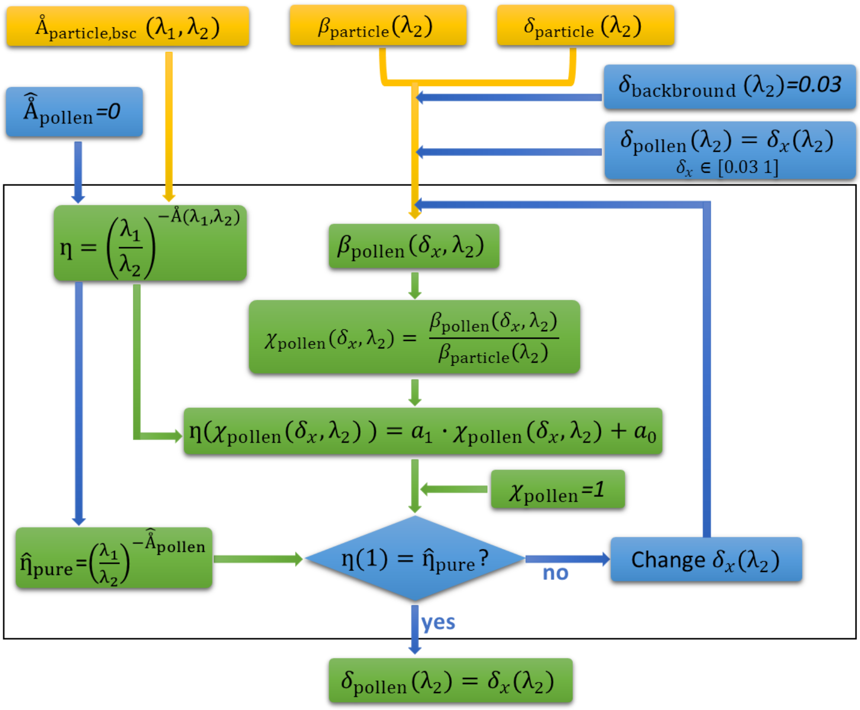

Figure 5. Flow chart of the inverse model for the retrieval of depolarization ratio value for pure pollen. The orange boxes are for the measured parameters (or simulated output from the direct model), blue boxes for the assumptions/manual input and the green boxes for the estimations/calculations. Detail description is in Sect. 3.2. The wavelength pair (λ_1, λ_2) is selected as (355,532), (532,355), or (1064,532) in this study.

”

Now some more comments regarding the manuscript:

C5 • I again strongly encourage you to separate the presentation of the methodology from the presentation of the results. This is customary in scientific writing and allows the reader not only to better follow your reasoning but also to separate more general relations from your specific results.

We agree, and change the structure as in reply to the comment C1.

C6 • I am quite sceptical about Section 3.4.2. You have defined no profile of β_{1064} and no $Å_{532=1064}$ in your synthetic data set. How could you know how to interpret your findings when applying this extended approach to real-life data? Your retrieval of δ_{pollen} at 355 nm is basically analogous to that at 532 nm. In fact, the choice of values in Table 3 indicates that profiles at 355 and 532 nm should be identical. Why not use the same method at 355 and 532 nm? This should already be discussed in the theory section.

As in our reply to the comment C1, there is a linear relationship (Eq.5) between $\frac{\lambda_1}{\lambda_2}^{-Å_{\text{particle}}(\lambda_1,\lambda_2)}$ and $\chi_{\text{pollen}}(\lambda_2)$.

For 1064 nm study, we use λ_1=1064 and λ_2=532, so $\eta' = \left(\frac{1064}{532}\right)^{-Å_{\text{particle}}(532,1064)}$ with $\chi_{\text{pollen}}(532)$ as parameters for the linear relationship. Thus using the pollen backscatter contribution at 532 nm ($\chi_{\text{pollen}}(532)$), we estimate the backscatter-related Ångström exponent between 532 and 1064 nm $Å_{\text{particle}}(532{,}1064)$.

For 355 nm study, we need to use $\chi_{\text{pollen}}(355)$ instead of $\chi_{\text{pollen}}(532)$, thus the wavelength pair should be λ_1=532 and λ_2=355 instead of λ_1=355 and λ_2=532, then the parameter should be $\frac{1}{\eta}$ instead of η. In our previous version of manuscript we used a 3rd parameter η'', but we changed it to $\frac{1}{\eta}$ for the revised manuscript.

More details are given in our reply to the comment C1.
In addition, in the revised version of supplement, we have added a section for the detailed calculation for Eq.5:

2 Relationship of $Å_{\text{particle}}$ and χ_{pollen} (Eq.5 in the manuscript)

Two aerosol populations, pollen (depolarizing) and background (non-depolarizing) aerosols are considered. The backscatter coefficient of the total particles is the sum of backscatter coefficient of both pollen and background aerosols:

$$\beta_{\text{particle}}(\lambda_1) = \beta_{\text{pollen}}(\lambda_1) + \beta_{\text{background}}(\lambda_1) \quad \text{(S7a)}$$

$$\beta_{\text{particle}}(\lambda_2) = \beta_{\text{pollen}}(\lambda_2) + \beta_{\text{background}}(\lambda_2) \quad \text{(S7b)}$$

Similar as Eq.2 in the manuscript, the backscatter-related Ångström exponent (Å) can also be expressed in this equation:

$$\frac{\lambda_1}{\lambda_2}^{-Å_x(\lambda_1,\lambda_2)} = \frac{\beta_x(\lambda_1)}{\beta_x(\lambda_2)} \quad \text{(S8)}$$

The index *x=pollen*, *background* or *particle* denotes the backscatter-related Ångström exponent of pollen, background or total particles.

We replace the top part of right side of Eq.S8 with *x= particle* with Eq.S7. And further use expression of $\beta_{\text{pollen}}(\lambda_2)$ and $\beta_{\text{background}}(\lambda_2)$ to replace the $\beta_{\text{pollen}}(\lambda_1)$ and $\beta_{\text{background}}(\lambda_1)$ in Eq.S7a, based on Eq.S8. Thus we have:

$$\frac{\lambda_1}{\lambda_2}^{-Å_{\text{particle}}(\lambda_1,\lambda_2)} = \frac{\frac{\lambda_1}{\lambda_2}^{-Å_{\text{pollen}}(\lambda_1,\lambda_2)} * \beta_{\text{pollen}}(\lambda_2) + \frac{\lambda_1}{\lambda_2}^{-Å_{\text{background}}(\lambda_1,\lambda_2)} * \beta_{\text{background}}(\lambda_2)}{\beta_{\text{particle}}(\lambda_2)} \quad \text{(S9)}$$

After replacing $\beta_{\text{background}}(\lambda_2)$ with Eq.S7b, the equation can be expressed as:

$$\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{particle}}(\lambda_1,\lambda_2)} = \frac{\left(\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{pollen}}(\lambda_1,\lambda_2)} - \frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)}\right) * \beta_{\text{pollen}}(\lambda_2) + \frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)} * \beta_{\text{particle}}(\lambda_2)}{\beta_{\text{particle}}(\lambda_2)} \quad \text{(S10)}$$

Using the definition of pollen backscatter contribution (Eq.4 in the manuscript), a linear relationship between $\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{particle}}(\lambda_1,\lambda_2)}$ and $\chi_{\text{pollen}}(\lambda_2)$ can be retrieved for the wavelength pair (λ_1, λ_2):

$$\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{particle}}(\lambda_1,\lambda_2)} = \left(\frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{pollen}}(\lambda_1,\lambda_2)} - \frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)}\right) \chi_{\text{pollen}}(\lambda_2) + \frac{\lambda_1}{\lambda_2}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)} \quad \text{(S11a)}$$

A similar formulate is found for the wavelength pair (λ_2, λ_1) when considering $\chi_{\text{pollen}}(\lambda_1)$:

$$\frac{\lambda_2}{\lambda_1}^{-\text{Å}_{\text{particle}}(\lambda_1,\lambda_2)} = \left(\frac{\lambda_2}{\lambda_1}^{-\text{Å}_{\text{pollen}}(\lambda_1,\lambda_2)} - \frac{\lambda_2}{\lambda_1}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)}\right) \chi_{\text{pollen}}(\lambda_1) + \frac{\lambda_2}{\lambda_1}^{-\text{Å}_{\text{background}}(\lambda_1,\lambda_2)} \quad \text{(S11b)}$$

C7 • While the information on pollen type and concentration in Figures 11, S4, S5, and S8 is certainly good to have, it is not needed in those plots. Instead, they distract from the intended message. As stated above, I'd expect that the display would work just the same using all values of χ(z). The ones outside the pollen layer should be easy to identify as (strong?) deviations from the desired relationship. Using the integrated parameter with the actual measurements might reduce signal noise. However, it requires knowledge of the base and top of the pollen layer as you don't want to include values of χ(z) outside of this layer in your integration.

We think these figure show data from real measurements, so it is good to present. Please also check our reply to the comment C3 for the reason of using pollen layer.
We have removed the fig.11 (in the original version of manuscript), and add a fig.12 (in the revised version). These 2 figures are similar, but in the new fig.12 we have applied the retrieved pollen depolarization ratio value, i.e. 0.24 instead of 0.2 for fig.12(a), 0.36 instead of 0.4 for fig.12(b).

C8 • You might want to state that this method can also be applied to other aerosol mixtures to retrieve the particle linear depolarisation ratio related to aerosol types that are dominated by coarse particles (Å355=532 = 0 needs to be fulfilled), as long as the particle linear depolarisation ratio of the second aerosol types is known or can be reasonably well approximated. An obvious application would be the retrieval of the particle linear depolarisation ratio related to undiluted mineral dust from different source regions. The lidar measurements for such a retrieval could be performed further away from the source regions, which translates into a strong reduction of logistical effort.

Thank you for the suggestion. We had mentioned such application in the end of section 3.3.2 of old version of manuscript, and we have modified it in Sect. 3.2 of the revised version:

"

This method can also be applied to other two aerosol types (e.g., dust and non-dust aerosols), under the condition that the depolarization ratio of one aerosol type is the only unknown parameter, and other parameters are known or can be assumed, as long as both the depolarization ratio and the backscatter-related Ångström exponent of the two aerosol types are different.

"

We have also added such information in the conclusion. At the end of the conclusion of the revised version, we have added:

"

This method can also be applied to other aerosol mixtures (e.g., dust and non-dust aerosols) to retrieve the particle linear depolarization ratio related to aerosol types, under the condition that the depolarization ratio of one aerosol type is the only unknown parameter, and other parameters are known or can be reasonably well approximated. Note that the two constrains mentioned in Sect.3.1 should be considered: both the depolarization ratio and the backscatter-related Ångström exponent of the two aerosol types should be different.

"