Atmospheric Measurement Techniques Discussions

Atmos. Meas. Tech. Discuss., referee comment RC2
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Comment on amt-2021-80

Anonymous Referee #2

Referee comment on "Mie–Raman–fluorescence lidar observations of aerosols during pollen season in the north of France" by Igor Veselovskii et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2021-80-RC2, 2021

General comments:

The authors present multiwavelength Mie–Raman–fluorescence lidar measurements during pollen season in France. The depolarization ratios at 3 wavelengths, and the fluorescence backscattering at 466 nm were used to characterize different aerosols (background, smoke, dust, and pollen mixture). Pollen are not yet as well characterized as other aerosol types, this study suggests a method of classifying pollen from other types using combined measurements of depolarization and fluorescence.

The dataset is interesting, and the manuscript is well written. However, I have two major concerns which should be addressed before publication.

Specific comments:

My major concerns:

1. The authors present a simulation in sect.3.1 (L156-174), to estimate the wavelength dependence on depolarization ratio of pollen. The results show a strong spectral dependence increasing with wavelength. They conclude that such increase of PDR with wavelength is an indication of the presence of pollen.

However, the presented simulation is based on too many assumptions. The conclusion here may mislead the reader about the wavelength dependence of pollen depolarization.

a) In fig. 2, the curve shape depends a lot on the assumptions you made. E.g., if I take the laboratory measurements in Cao et al. 2010 for birch pollen, depo355 = 0.08, depo532 = 0.33, depo1064 = 0.28, the simulated PDR1064 will be smaller than PDR532 when betaP(532)/beta(532)> 0.8. And if ÅE values are different from your assumptions, the curve slope/shape can change a lot.

b) L168, you only mentioned depo1064 exceeded depo355, but in Cao et al., for most pollen types, depo532 are higher than both depo1064 and 355.

c) L172, "similar spectral dependence can be provided also by the dust particles". For coarse mode dust, laboratory studies show values: depo355=0.27, depo532=0.37, and depo1064=0.27. see review of Mamouri and Ansmann, 2017 and reference therein for more details.

Mamouri, R.-E. and Ansmann, A.: Potential of polarization/Raman lidar to separate fine dust, coarse dust, maritime, and anthropogenic aerosol profiles, Atmos. Meas. Tech., 10, 3403–3427, https://doi.org/10.5194/amt-10-3403-2017, 2017.

d) L308, "expected ratio depo1064/depo355 is about 2.3". I don't think you can use the simulated ratio as an expected value for the observations.

In fig.8b-c, the observed ratio agrees with the simulation, but in fig.8e-f, fig.10 and fig.11, there is no such agreement.

Fig.10, depo532 almost equal to depo1064. Totally different than the simulation.

Fig.11, at 1250m, depol355=depo532 = 0.14.

More discussions on those wavelength dependencies on depolarization ratio are needed.

e) L170-171, L282-283, L249-250, the related conclusions/descriptions should be checked.

If you want to include such simulation in this study, more complete investigations should be done, and more discussions are needed here. I understand that your choice of parameters is not critical for presenting the approach. Nevertheless, it would be nice to get an idea of why those specific values have been selected (e.g. pollen depol, ÅE).

2. Using depolarization ratio and fluorescence for the aerosol typing is of great value. The fluorescence capacity can be a very good indicator for pollen presence. Also, it is very interesting to show the wavelength dependency on depolarization ratios from observations, which could be one characteristic of pollen.

However, more information on pollen should be added: Are they really pollen? Which pollen type?

a) L137, “pollen observed in the boundary layer by the lidar are probably transported from other regions.” Short-range or long-range transported? The air mass origins are not always presented for some cases.

During the campaign, is there any good cases with local pollen? At the beginning of April, there were high pollen concentrations (mainly betula), together with hight fluorescence bsc. It will be very interesting if you have any good cases during that period. Characteristic values for different pollen types can vary a lot.

b) L126-139, you discussed about the links with high fluorescence with presence of pollen at ground level, but as the conclusion you said no direct correlation. It is a bit confusing.

c) You have chosen observations with high fluorescence and high depolarization for pollen study, what if there is smoke and dust mixture?

My main comments:

3. The full overlap is ~1000 m (sect.2.1). Have you performed the overlap correction on lidar signal? if yes, what was the lower limit after the correction?

a) L130, fluorescence bsc, maximal values in 500-1000 m range, do you mean “range” or “height” here? These values are after the overlap correction?

b) Fig.6, optical profiles at 500-1000 are reliable? with an overlap correction?

4. L145, “the pollen loading in the north of France is significantly lower”, this is not correct. Regarding fig.1, daily concentration of birch pollen is similar as 2h concentration reported in (bohlmann et al., 2019), ~3000 m-3 for the peak value; and much higher than pollen counts reported in sassen et al. 2008. If you take 2h pollen concentration, you may have even higher values.

I suggest you plot the 2h pollen concentration instead of daily one, which provide more information. High pollen concentrations are often observed during daytime, but it can also present at night.

Technical corrections:

- L40, 694 nm, not 0.694 nm.
- L44, please also give the region of the mentioned pollen studies.
- L50, a recent paper of bolmann et al. 2021 on depol ratio at 3 wavelengths is worth to be mentioned in the introduction.

Bohlmann, S., Shang, X., Vakkari, V., Giannakaki, E., Leskinen, A., Lehtinen, K., Pätsi, S., and Komppula, M.: Lidar Depolarization Ratio of Atmospheric Pollen at Multiple Wavelengths, Atmos. Chem. Phys. Discuss. [preprint], https://doi.org/10.5194/acp-2020-1281, in review, 2020.

- L144 change 2011 to 2019.
- L197, fig.1 not 1a
- L239, "suggesting that this layer may contain smoke or pollen particles". From the figure, depo1064 of the layer at 1600 m is about 0.08, depo1064 of the previous smoke case is only 0.015, Can you state on this? Back trajectories for layers of this case (sect.3.4)?

- L263, was there a RH threshold you used?
- L285, pollen are medium to high absorption particles in the literature, how to explain the difference on low lidar ratio with literature?
- L288, EAE=2, fine mode particles are dominant.
- L326, volume depolarization at 1064 is above 15%? Please check. In fig.10, particle depol. 1064<0.15
- L345, what is the typical value for the pollen?
- L356, unit for beta is "Mm-1 sr-1"
- L357, VDR at 1064 nm? For the layer, VDR1064>0.1 but PDR1064 is only 0.08 (L362)?

- L383, how do you define: "when the contribution of pollen to the total particle backscattering was significant."
- L399, for smoke, "high Gf" not "low Gf"
- L408, if you assume pure pollen depolarization ratio of 0.2-0.5, how Gf values range?
- Fig.1, you can add the presented cases in the figure.
- Fig.6, in x-label and the caption, beta1064 or beta532?
- Fig.7, add RH profile for the hygroscopic growth study.
- Fig.10, please provide in the caption the depol values you used for the retrieval of the pollen bsc coefficient.