Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-291-RC3, 2020

Atmospheric Measurement Techniques Discussions

Interactive comment on "Combined use of Mie-Raman and fluorescence lidar observations for improving aerosol characterization: feasibility experiment" *by* Igor Veselovskii et al.

Anonymous Referee #3

Received and published: 12 October 2020

Summary: The manuscript reports on fluorescence measurements of atmospheric aerosols with a multi-wavelength Raman lidar, where the interference filter in the water vapor Raman channel was replaced by a broadband filter around 466 nm.

Although the study contains some interesting approaches, e.g. the possible synergy of combined measurements with multi-wavelength Raman lidar and fluorescence lidar, it is incomplete and too speculative at this stage and requires substantial extensions and improvements for a possible publication. For example, it is incomprehensible why the authors do not present aerosol events that could show the real strength of their modified lidar system (microphysical retrieval plus fluorescence), but only those that are actually

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not suitable. A little more patience would have been necessary here. Furthermore, the paper shows technical weaknesses in both the experiment and the analysis, and the interpretation of the measurements is highly speculative. For example, the fluorescence measurement has not been thoroughly calibrated, and no backward trajectories were used for aerosol typing. Furthermore, the measurement results are discussed using relative humidity, although neither water vapor measurements with the lidar nor local radiosondes were available. Interestingly, the authors themselves point out some of these weaknesses in their conclusions, they should fix them and then resubmit the manuscript.

Major issues:

1. The calibration of the lidar was not performed with a spectral lamp (l. 169 ff), so the measurement trueness is questionable, and the authors are aware of this (l. 380 ff). Why was the calibration not performed? Nevertheless, the measurements are quantitatively evaluated and interpreted, this is not a consistent approach.

2. The authors speculate about the presence of aerosol mixtures (l. 204 ff). This can only be investigated with spectrometric fluorescence lidars, if at all. But at least an analysis of the backward trajectories should have been performed. This also applies to the statements regarding the change of G_F (l. 225 ff).

3. Relative humidity is used for the interpretation of the measurements, although it is not known sufficiently for these purposes, especially for hygroscopic aerosol growth (l. 211 ff). Thus the interpretation is a speculation.

4. Particle depolarization is not only a function of particle shape but also of particle size, this should be considered in the discussion.

5. The whole microphysical interpretation (l. 244 ff) is pure speculation. Why did the authors not wait for aerosol measurement cases where they could have used the strengths of their multi-wavelength Raman lidar?

6. The reviewer is sceptical about the measurements in chapter 3.2, which are supposed to prove an internal mixture of aerosol particles and cloud droplets (l. 311 ff). It is noticeable that the fluorescence signal associated with the cloud layers seems to be a function of the measurement height: below 1000 m very high 'fluorescence' values are found in clouds, around 1500 m slight increases, and above 1700 m elastic and fluorescence signals are uncorrelated. This may (but of course does not have to) indicate instrumental effects (height-dependent angle-of-incidence distribution of the backscattered photons). Are there measurement examples where liquid water clouds below 1000 m do not show increased fluorescence?

Minor issues:

1. The authors claim that lidars with spectrometers are less sensitive than those with standard detection channels (l. 61 ff). However, a comparison with published spectrometric measurements seems to contradict this. Please explain in more detail.

2. The authors plan to reduce the bandwidth of the interference filter for fluorescence measurements by a factor of 2 or even 4 in the future (l. 404 ff). However, this would further increase the measurement duration, which is already very long. Please explain in more detail.

Wording:

1. To speak of a 'highly efficient lidar operation' (l. 368) when in fact hour-long integration times are needed for fluorescence measurements is quite a stretch.

Type setting:

1. All variables in the running text and in the equations must be checked for correct math format. There are many formatting errors, for instance, variables are not italic (e.g., l. 133), or subscripts are italic (e.g., l. 119).

Figures:

1. Figures 1 and 7 are of poor quality.

2. Figure 6, colors for beta_1064 and beta_F are hardly distinguishable when printed.

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