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Atmospheric Measurement Techniques Discussions

Interactive comment on "Year-round stratospheric aerosol backscatter ratios calculated from lidar measurements above Northern Norway" *by* Arvid Brand et al.

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(Author responses are in blue. In the tracked changes version deleted sequences are marked red. New text is marked in blue.) General Comment: We want to thank the three reviewers for the detailed reviews with many useful ideas and suggestions which, we think, have significantly increased the quality of the manuscript. We have rewritten a substantial portion of the manuscript. We restructured the outline of the manuscript. Section 2, formerly named "ALOMAR RMR Lidar" is now called "Instrument and Method" with subsections 2.1 "Processing of the raw data", 2.2 "Calculation

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of backscatter ratios" and 2.3 "Identification of the stratospheric aerosol layer". Section 3, formerly named "Methodology" is now named "Calculating the backscatter ratio under daytime conditions". Section 4 contains the results of the paper. A "Summary and Conclusion" can be found in section 5. The nomenclature for the calculation of the backscatter ratio and the color ratio was changed. Therefore, sections 2.2 and 3 have been completely rewritten. The figures have been updated to account for the new symbols.

This paper presents the analysis of stratospheric aerosols observations using the state of the art Rayleigh-Mie-Raman multiple wavelength lidar at ALOMAR. The stratospheric aerosol layer is observed at 1064 nm with unprecedented high resolution. The topic of the paper is well suitable for publication in AMT. However the description of the data processing and the results should be improved and I recommend a major revision as detailed below.

Equation (1) page 3 for the dead time correction does not seem correct. The correct formulation is: N=Ncount/(1-tau Ncount)

Corrected

Page 6, lines 10-11, how equation 3 could be applied if the inelastic signal is not present?

We have used the inelastic signal as measured during the night. This was made clearer in section 2.3.

Page 6, lines 15-21, the justification for a linear correction with altitude of the R355/387 is not given. It may hide some instrumental problems in the lidar. This point should be discussed in more details.

A new paragraph was added to cover this comment in section 3: "First of all we have not identified an instrumental problem that leads to this linear decrease with altitude; for example an incomplete overlap function would affect both signals S355 and S387

in the same way. Furthermore Ozone extinction can be excluded as potential source of error as it has virtually no impact on these signals."

Also I wonder why the ratios R532/387 and R532/355 on Figure 4 fall below 1 in the lower altitude range. Is it a problem of detector saturation?

An explanation for this issue is now given in the manuscript: "'$R^5 32_3 87$ is affected by ozone extinction. By definition a backscatter ratio should not be smaller than 1. This indicates that the true ozone extinction may be different from that used for processing the data since the signal at $\lambda = 532$ nm is stronger affected by ozone extinction than the signal at $\lambda = 355$ nm. Due to the normalization of the backscatter ratio to 1 in the aerosol free altitude z_F an under-estimation of ozone extinction reduces the backscatter ratio and may result in $R < 1$. A similar effect arises due to a wavelength dependent extinction of the aerosol layer. Here R is reduced at lower altitudes if the wavelength of the elastic backscattered signal is more affected by aerosols than the Raman wavelength."'

Results section page 7 How the standard error of the monthly mean scattering ratio is computed? Is it from the statistical error on lidar signal at different wavelengths? Due to the limited number of available hours of measurements per month and the large variability of the Artcic stratosphere, especially during winter months, the monthly averaged value of the scattering ratio cannot be considered as fully representative of the monthly climatological value for this month.

The standard error of the monthly mean backscatter ratio is computed like follows: $\sigma_m(R) = \sigma/sqrt(n)$ with sigma being the standard deviation of the backscatter ratio for each month and n being the measurement time in hours for each month. This information is now included in the revised manuscript.

Page 7, lines 27-29, the increase of aerosol loading in the lower stratosphere in August-September due to smoke from the Canadian fires merits to be discussed in more details than just put in the mean seasonal cycle.

A reference to a detailed discussion of the event is now given in the revised version. We mention the wildfires just shortly as a confirmation for the reasonable results of the aerosol retrieval.

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