Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-289-RC1, 2020

Atmospheric Measurement Techniques Discussions

Interactive comment on "Validation of temperature data from the RAman Lidar for Meteorological Observations (RALMO) at Payerne. An application to liquid cloud supersaturation" *by* Giovanni Martucci et al.

Anonymous Referee #3

Received and published: 14 October 2020

Summary:

The manuscript takes a comprehensive look at the temperature measurements with the Raman Lidar at the MeteoSwiss station in Payerne, RALMO. The focus is on the validation of the measurements, but a detailed description of the experimental setup is also given. RALMO utilizes the pure rotational Raman (PRR) technique, but in contrast to other instruments the PRR signals are separated by two fiber-coupled consecutive grating spectrographs. The technical design showcases an impressive long-term stability, which makes comparisons with radiosonde soundings for calibration purposes

a rare necessity. It follows a detailed description of the processing of the measurement signals from their recording, correction for dead time and background effects to the determination of the calibration constants of the temperature measurement. The error budget is also discussed. The validation of the PRR temperatures is the central part of the manuscript. For this purpose, a measurement data set of several years is used, which is compared to a large number of quality-tested temperature profiles from local radiosonde ascents or model data. Different aspects such as diurnal cycle and seasonality are investigated. The agreement is impressively good, as evidenced by various statistical parameters. Finally, as an application example, the water vapor supersaturation in liquid water clouds is examined. Besides the PRR temperatures the water vapor mixing ratio, also measured by RALMO, is used for this purpose. This study could have been more detailed, however, some questions remain open. In view of the considerable length of the manuscript and the fact that description of the lidar instrument, and data evaluation and validation of the PRR temperatures are clearly the focus of the paper, the authors should consider to remove this section from the manuscript and publish it separately. In summary, the manuscript is well written, the results are important and worth publishing. Only some polishing is recommended.

Section 1:

1. The last two paragraphs should be combined to avoid repetition.

Section 3:

1. Page7, Line 8: If only 2 of the 4 telescopes are used for temperature and humidity measurements, what are the other 2 telescopes for?

2. P7, L7: The tilted filter induces polarization effects. Have polarization issues been studied?

3. P8, L6: Please name type and manufacturer of the PMTs.

Section 4:

1. P12, L16: Probably, the step width is 0.01 ns?

2. P12, L26: The dead times differ significantly. Do you have an explanation? Do you use different PMTs?

3. P13, L4ff.: Why is this so? At 50-60 km, the 'weaker' (as you say) J_high signal should contain only background photons, and so, in theory, background subtraction should be OK.

4. P15, Fig. 9 (and others): The temperature profiles are presented starting at 500 (or 600)m. Given the fact that Payerne is at about 450 m asl, this is quite close to the ground and probably within the region of incomplete overlap. At what altitude does RALMO reach full overlap? Do you have instances where an incomplete overlap may have caused measurement errors?

Section 5:

1. P17, L1ff.: Exclusion of measurements within clouds from the statistics are justified by the attenuation of the signals and the subsequent increase in SNR. Because of the proximity of the elastic line, however, blocking might be an issue as well. Have the authors attempted to measure PRR temperatures in clouds? How well does the double-polychromator setup suppress elastic light in the PRR signals? Up to which backscatter ratio (BSR) can the PRR temperature be considered unaffected by particle scattering? Are there any polarization effects?

Section 6:

1. P25, L20: The 'clouds' presented are actually extremely thin. Even if the stratus were broken, to obtain a mean BSR of only 4 would mean that most of the integration time there was no cloud at all, or only swollen aerosols were present. Profiles of the cloud optical properties [backscatter coefficient, extinction coefficient, lidar ratio (, and depolarization ratio; but probably not available)] plus RALMO humidity and PRR temperatures would make it possible to assess the measurement situation and the

RALMO performance much better. Co-location of maximum RH and BSR sounds a bit suspicious, s. blocking comment above. As already mentioned in the summary, the reviewer recommends to discard this section.

Math, equations and running text (all):

1. All variables must be in italic.

2. If not a variable, text must not be italic, e.g.: O_2, N_2, high, low, Stokes, AntiStokes, fit, sig, SB, TD, season, max, ss, . . .

Figures:

1. Fig. 4: There is no wavelength scale as stated in the caption.

2. Fig. 5: Is there a 'degree' symbol after 'to Aerosol &T'?

3. Fig. 5: The depiction of the water vapor spectrum would be more realistic if the steep slope was on the blue shoulder.

4. Fig. 6: There are many more holes in the blocks (at the edges) than explained in the running text. What are they for?

5. Figs. 10, 11: Use same style for panels left and right. Use same x range for STD in both figures.

6. Figs. 14, 16: Harmonize x ranges as much as possible. For instance, use 0-120 for availability in all panels, 0-1 for STD.

Tables:

1. Tab. 2: There are entries missing down in the third column.

Typos:

1. P3, L5: '. Our'

2. P3, L13: '. Moreover,'

3. P3, L19: ‘possible causes’
4. P4, L7: ‘2018)’
5. Caption Fig. 2: ‘2b).’
6. Caption Fig. 3: ‘figures.’
7. P6, L30: ‘transceiver’
8. P7, L2: ‘of the signal’
9. Caption Fig. 6: This is not the correct text (has been copied from Fig. 5).
10. P11, L11: ‘is used to’
11. P17, L16: ‘are the metric’
12. Caption Fig. 10: Explain ‘STD’.
13. Caption Fig. 11: Explain ‘STD’.
14. Caption Fig. 12: ‘Differences between RALMO and COSMO temperatures’
15. Caption Fig. 12: Include date of sunrise and sunset plotted.
16. P20, L2: ‘November;’
17. P20,L20: ‘Like spring’
18. Heading, Tab. 6: Explain ‘TD’.
19. P21, L8: ‘from the instrument’
20. Heading, Tab. 7: Explain ‘TD’.
21. P25, L24: Define ‘ss’.

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