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Atmospheric Measurement Techniques Discussions

Interactive comment on "Retrieval of Temperature From a Multiple Channel Pure Rotational Raman-Scatter Lidar Using an Optimal Estimation Method" *by* Shayamila Mahagammulla Gamage et al.

Anonymous Referee #1

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The authors present the application of the OEM to pure rotational Raman (PRR) temperature lidar. The OEM has been applied before to other lidar techniques but not to this one. Compared to how PRR temperature lidar data were analysed previously, the OEM shows several advantages, the largest of which is that no calibration with other sensors is needed. Furthermore, the systematic and statistical uncertainties as well as the effect of partial overlap in the near range are also determined.

The authors could highlight these advantages even more clearly. There is one early study on calibrating RRL temperature lidar with the instrumental parameters (Vaughan

et al.: Atmospheric Temperature Profiles Made by Rotational Raman Scattering. Applied Optics, 1993) but this study concluded that the uncertainties were too high at that time.

The paper is mostly well written (see detailed below). My recommendation is to accept the paper after minor revision.

Specific comments:

Since the proposed technique seems to be universally applicable to temperature rotational Raman lidar systems, more references to the state-of-the-art of this technique and other existing systems would certainly be interesting for the readers and should be included.

You mention two assumptions on page 8, line 25/26. What do you mean with "well known"? How critical are these assumptions? When highlighting which assumptions are NOT needed (see abstract, introduction, conclusions), you should be fair and also mention which are needed. Maybe it would be interesting to explain also in the abstract and conclusions that (how much) the results are independent from the selected a priori temperature profile.

Page 9, line 4: There are always aerosols in the troposphere. How few are acceptable? I think the term "digital measurements" for photon counting signals is odd. Also the analog signals are digitized. Thus, I suggest that you write "photon counting" throughout the text.

Minor comments:

"Lidar constants" and "coupling constants" are terms which are not commonly used. Please define/explain or avoid. E.g., page 1, line 5: "ratio of efficiencies" is better I think since the laser power, transmitter efficiency, telescope area are the same for both channels and thus cancel and become irrelevant (if I understand correctly).

Page 1, line 21: "...2 flights per day". One could add: "only at selected sites world-

wide”.

Page 1, line 22: Please add references to other combined Raman lidar systems. There are several which measure water vapor and temperature.

Page 3, Eq. 1: You assume that all PRR lines of one channel are collected with the same efficiency. This is generally not the case but may be true for RALMO. Please add a comment on this.

Page 3, Eq. 2: This equation is not found in Penney et al. 1974.

Page 5, line 11: Why is the background noise B_RR a function of height? I think the “real background” should be height independent. If the baseline is height dependent, detector non-linearity or electronic cross-talk is present, I guess.

Page 7, table 2: What do you with “transition height”?

Page 8, line 6: beta_par *is* related

Page 9, line 20: I would prefer “model parameters” or “model b parameters”

Page 9, line 21: Please refer to the figure.

Page 10: line 6: What do you mean with “dominant”?

Page 10, line 7: How do you know that the analog signals are linear?

Page 10, line 8: “become saturated”. What do you mean with “saturated”?

Page 11, Fig 2: I suggest that you write “four signals”. It is *two* channels. How did you determine “measurement noise”? With OEM? Please clarify.

Page 14, line 2: What is coupling constant R_a? How is it defined?

Page 15, Fig 6: How did you obtain the a priori overlap? Why is this important since the ratio of the overlap functions cancels?

Figs 1, 7, 12, 17: I would prefer the same scales. JLa -> JL, JHa -> JH? Should be

consistent. I think it would be interesting to show the elastic signals for all cases. Why “Eb” for “elastic”?

The language still needs polishing/corrections. Here two examples:

Page 1, line 3ff: “assumption for the form of . . .” However, I think the form of the calibration function is not really the point here. Calibration with external sensors (with all the uncertainties related to the accuracy of the reference sensor and to the sampling differences) is usually needed but overcome with OEM.

Page 1, line 13 & 15: “under different sky conditions”, “under clear and cloudy conditions”

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