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Atmospheric Measurement Techniques Discussions

Interactive comment on "Mesospheric temperature soundings with the new, daylight-capable IAP RMR lidar" *by* M. Gerding et al.

Anonymous Referee #2

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This paper provides a technical description of a state-of-the-art Raman-Mie-Rayleigh lidar system which is in operation at the Leibniz-Institute of Atmospheric Physics since 2010. Several techniques (small field of view, narrowband optical filters in the receiver, transmission at a Frauenhofer line) are used to reduce the solar background, thus making it possible to retrieve temperature profiles up to approximately 75 km in full daylight. This is a significant achievement as the new lidar system allows temperature observations in the stratosphere and lower mesosphere over full diurnal cycles. Such long observations are of scientific interest for studies of e.g. thermal tides, diurnal variation of (convective) gravity waves. The lidar system is also notable for its stable operation with more than 6000 hours of observations so far (> 1000 hours per

year). The work presented in this paper is appropriate for publication in Atmospheric Measurement Techniques.

Specific comments:

1. Gerding et al. present many interesting details of their lidar system in this paper. However, it is hard to compare the performance to other lidars based on retrieved temperature profiles. I suggest the authors add a figure showing a raw photon profile, e.g. one hour integration time.

2. The correction of spectral distortions in the backscatter signal induced by the double etalon is enlightening. I am wondering: did the authors consider validating their calculations by comparing signal ratios measured by detectors before and after the etalons for different altitudes (temperatures)? For example, the authors could derive the transmission of the double etalon at the stratopause (high temperature) and in the mesosphere (low temperature). The comparison could provide insight whether the instrument function of the (real) etalon is indeed an Airy type function.

3. The calculations are based on the assumption that the lidar transmits at the wavelength of peak transmission of the etalons. What is the precision of tuning the etalons to a specific wavelength? Can the authors provide an estimate of the temperature error caused by an improperly tuned etalon (e.g. wavelength of peak transmission is offset by 0.5 pm)?

Minor comments:

Page 3, line 11: "The emission wavelength of the seeder is monitored by a High Finesse WSU wavelength meter." Is the wavelength meter used to stabilize the seeder? Please clarify.

Page 3, line 24: "The fiber cable has a diameter of only 0.2 mm. . .". I assume the core of the fiber is 0.2 mm in diameter and the cable is larger.

Page 4, line 2 and Figure 2: Please mark detectors "532/1", "532/2", "532/3" in Figure

2.

Page 4, line 6: “Tuning of the etalons is done by changing the pressure inside the stainless steel housing”. Please explain in more detail how the etalons are tuned. Is the transmission monitored as function of pressure? How often do the etalons need to be tuned?

Page 4, line 7: The transmission of the etalons (“∼92%”) is very high. How was the transmission measured?

Page 4, line 14: “the background count rate form solar backscatter is reduced by about five orders of magnitude compared to our nighttime RMR lidar” How do the authors estimate the reduction in background count rate in daylight if the nighttime RMR lidar can only observe during darkness? Please explain. This also concerns Figure 3: How is the background extrapolated? Can the authors provide key parameters of the nighttime RMR system (e.g. field of view, bandwidth of interference filter)?

Page 5, line 1: “As described in Table 1. . .” The bandwidth of the etalons is not listed in Table 1.

Page 5, line 6: “. . . from the pulse length”. Did the authors measure the pulse length? If yes, please provide information.

Page 5, line 7: “. . . calculated the effect of larger bandwidths and found that that the additional correction . . . is much below 0.1 K”. How large is the initial correction for 45 fm bandwidth? How large is the wavelength jitter of the laser and how much does this jitter affect the transmission?

Page 5, line 18: “. . . the transmission changes between 0.86 and 0.79.” Figure 4 (left) suggest that these numbers are valid for ideal etalons with 100% peak transmission. The transmission of the real double etalon would be lower in this case. Please clarify.

Page 6, line 7: “. . . this may be due to different (signal dependent) smoothing windows used for both lidars.” Please explain.

Page 7, line 15: “The diurnal tide maximizes at ∼43 km (amplitude ∼5 K), nearly vanishes below 50 km . . .” “Vanishes” is not quite correct, in my opinion. The maximum (∼43 km) is below 50 km.

Page 7, line 17: “The semidiurnal tide in March 2014 is alternately increasing and decreasing, suggesting several filtering layers for the particular tidal mode”. I am not entirely convinced. The vertical wavelength of the diurnal tide is large compared to the vertical separation of the “filtering layers” (e.g. minimum at 57 km, maximum at 62 km). Could the modulation in amplitude be caused by gravity wave-induced temperature perturbations which are not entirely suppressed in the composite analysis?

Figure 4: Caption reads “. . .Rayleigh backscatter spectrum before etalons (blue). . .”, but the blue label reads “Voigt after FPE 1”

Figure 7: Please state the temporal resolution.

The language may be improved, e.g. “The computer-controlled beam stabilization fixes the beam axis. . .”, “The thin fiber with numerical aperture NA= 0.11 allows to build up. . .”

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