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Atmospheric Measurement Techniques Discussions

Interactive comment on "Combining ground-based microwave radiometer and the AROME convective scale model through 1DVAR retrievals in complex terrain: an Alpine Valley case study" *by* Pauline Martinet et al.

Anonymous Referee #2

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Ground-based microwave radiometer (MWR) can perform continuous unattended measurements of the atmospheric temperature profile. The vertical resolution is best close to the ground and decreases with altitude. The manuscript demonstrates the quality of the temperature retrieval using a 1D-variational framework for the special conditions of the stable boundary layer in an Alpine valley. It makes uses of a rich radiosonde (RS) data set for evaluation purposes identifies systematic problems in the high-resolution weather forecast model Arome. Several investigations in respect to the sensitivity of the apriori (from Arome and RS) and for different conditions are performed which show

the potential of MWR to improve numerical weather forecast models.

The manuscript is well written, addresses an important topic and presents interesting results which can have high impact on the future observation network. In addition to some major points and recommendations I add a list of minor comments below.

1) In the introduction, the authors pose the question whether the surrounding mountains in the narrow valley affect the microwave observations. However, this is not really investigated in this study as only a comparison with radiosondes is made. Neither the atmospheric volume observed by the radiometer nor the flight track of the radiosonde is considered. One would need to calculate the effect of the antenna pattern or perform azimuth scans to see at which point the mountain slopes are in the field of view. In fact a simple calculation shows that even for transparent channels which receive radiation over the full extent of the atmosphere, mountains in 2 km wide valley should not provide a contribution to the main beam (2.5 deg FWHM). As side lobe suppression is -30 dB this is unlikely to contribute. More interesting is the question how strongly the true temperature field varies across the valley, e.g. is there any influence of mesoscale circulations or solar insolation? I do not expect the authors to perform an elaborated analysis in this respect but a more careful wording is necessary, e.g. "..thus can be safely deployed in complex terrain.."(p8, l5) or at p13,l1. It would be very interesting to know if the boundary layer scans performed in the two different directions as indicated in Figure 1 differ from each other?

2) As far as I know the HATPRO standard regression boundary layer temperature retrieval makes use of the inbuilt in-situ temperature measurements. This might explain the good performance despite the lack of bias correction. However, the HATPRO sensor should not be as accurate (representative) as the weather station - did you intercompare them?

3) The authors use radiosonde measurements down to 10 m, however, the first roughly 100 m of the radiosonde ascent suffer from the fact that the sensors are not fully vented,

Do the authors have some information on this from the tethered balloon measurements?

4) A short discussion on the vertical resolution of the MWR should be included. Löhnert and Maier (2012) smooth the radiosonde profile with the averaging kernels for comparison to take these effects into account but here you are interested in the optimal retrieval. In fact, this discussion would support your outlook that the inclusion of infrared radiometers and lidar could improve the vertical resolution (p26, l27), cf Barrera et al., AMT, 2016. I do not agree that this would help only below clouds: IR and lidar give information below clouds and thus the information content from the MWR could be exploited for the higher levels.

5) Fig. 8 shows a bias of about -5 K with STD of about 3 K. Looking at Fig.3 the difference between Arome and RS is certainly not Gaussian distributed - what is the impact on the B matrix? This might be discussed in respect to the question what the optimal way to build the B-matrix is, e.g. dependence on flow and diurnal cycle?

Minor comments:

p7,l28: "..and those extracted from" p8,l31: larger errors during unstable conditions". It is not necessary unstable but rather neutral with about 10 K difference between surface and about 1 km. You should rephrase and maybe just mention your stability index p10,l3: A more . p7,l19: One sentence explaining O-B would be helpful - maybe the last sentence of the paragraph? p10,l7: "Note, that the small amount.." p12,l4: Did you look at the variability of Arome within the valley? p12,l13: Did you check the retrieval at 0 m - this is a different site than in Martinet 2015? p13,l6: Which type of instrumental errors do you expect: drifts, calibration jumps? p14, l19: only for clear-sky? p15, l4: is observed -> is evident p15,l9-10: How is this done in detail - should be reproducible p15, l13: standard HATPRO linear regressions p15, l15: raw measurements makes me think of voltages...uncorrected TB + Tsurf (see point 2) p16, l1: I don't think plural of background exists. p16, l2: both IDVAR is confusing as three lines are shown. p16,

l17-24: This discussion describing Fig. 10 needs to be integrated with the previous paragraph (1-17) describing Fig. 9 as Fig.9 is only a blowup of Fig.10. This is just one story. For example, in line 6 the 0.7 K is mentioned that one can only see in Fig. 10 (actually it looks like 0.6). I also suggest to merge Fig. 9 and 10 to a 2x2 figure which would make it much easier. p16, l30-35: I am very surprised that there is a larger diurnal cycle in the difference between T2.5 and T1.5 than between T5 and T1.5? Did the values get mixed up by any chance? Please add the altitude of the HATPRO retrieval? p18, l10: At bit provocative: When you use the RS as a priori and also evaluate with an RS one could argue that systematic RS errors (time lag, calibration..) might be similar and therefore Arome has no chance? p24,l7: I do not understand how the valley constrained the measurement configuration - do you mean the difficulty to find a site with a free view?

Fig.6: This is much better than the first version but I cannot distinguish the two green (90 and 10.2) and the two red (42 and 19.2) lines - I think it would be better to reduce the number of angles and leave out the middle ones Fig.7: same color problem as for Fig. 6, better delete title (56) and add to caption Fig. 9: can't distinguish the two red lines Fig11-15 difficult to read -> larger

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