Review: Combined Vertical-Velocity Observations with Doppler lidar, Cloud Radar and Wind Profiler. By, J. Bühl, R. Leinweber, U. Görsdorf, M. Radenz, A. Ansmann, and V. Lehmann

The dataset presented in this paper is very interesting and worth of publication, the potential to deliver excellent insight in aerosol-cloud-precipitation processes is definitely there. However the paper proceeds somewhat hastily from first-order assessments to conclusions. There is a surprising lack of discussion of the different spectral responses of the three instruments to various types of targets, and the 'retrieved velocities' seem to be treated all the same way (see comment on Figure 7). Much of the evidence presented is not clearly supporting the statements. I don't think the authors actually ignore the former, or that they can't provide the latter, but in this manuscript they are not evident. It would require substantial expansion and quality control to become publishable.
I also recommend to rebalance the text in highlighting the unique value of each of the three measurements. The authors do emphasize the synergistic value of having these three measurements collocated, but as it is, it seems the text tends to give the impression that advocacy for Doppler lidar over the other two may be affecting the selection of arguments. In some cases the claims seem very reasonable and well substantiated, but in other cases they appear either weak or even biased. It would be helpful if the authors highlighted the unique information provided by each measurement in a more detailed fashion.

Recommendation: Major revision.

Major comments:

Figure 4: by visual inspection only of the upper panel I cannot concur with the authors that Profiler and Lidar concur more often and only the Radar has outliers. I see one Radar outlier at ~4300 UTC, but also an area where Lidar and Radar agree, and Profiler is outlier at ~4400 UTC, and an area where Radar and Profiler agree and Lidar is outlier at ~4750 UTC. I will not draw conclusions based on this, other than a more quantitative analysis and specific explanation must be provided to make the stated point.

In regards to the fact that only lidar can make measurements at 100 m above the ground, also some more explanation should be provided. Since the Radar and Lidar have the same range resolution one would expect similar short range performance, any difference should be due by specific technical details adopted in each one based on affordability etc. A radar of 60 m resolution can be designed to detect targets at 100 m distance if one makes it a requirement for the system. The statement as provided in the manuscript is so general that one would think this being an intrinsic property of lidar vs radar, which would be incorrect. At the very least, it should read "For observation in the boundary layer it is most notable that, at the MOL site, the Doppler lidar . . " or something to that effect.

Figure 5: I have a question regarding the layer between 1300 and 2100 m and between approximately 11:08 and 11:10 UTC. The lidar and profiler indicate an upwards velocity of less than 0.75 m/s, but the radar indicates an upwards velocity of more than 1 m/s. In this case indeed it is the radar to be the outlier, but the departure goes opposite to what I would expect. I don't see any obvious signs of aliasing, and the terminal velocity of falling particles if anything should have biased the radar velocity towards negative numbers. If this is insects, they should affect lidar and radar similarly in terms of velocity, correct? Is this a mix of insects and cloud droplets? What is the explanation for this difference? Are the authors confident that such data are reliable and not too close to the minimum SNR necessary to obtain well correlated signals?

The following is perhaps the most important criticism.
Figure 7:

a) Could the 'low bias' be due to Rayleigh contamination on the wind profiler? If the wind profiler velocity is that of air motion minus a small contamination from the Rayleigh scatterers, when one subtracts the radar estimates a negative number can arise. In general, I consider the explanation offered here as potential, but I don't see enough data to truly support that. The available data should be analyzed in greater debt to promote this from "hypothesis" to "finding".
b) Also, the authors don't address at all that for each of the three wavelengths the "mean Doppler velocity" observed is weighted by the specific response of the distribution of Bragg and backscattering of various particle sizes accordingly. Based only on the evidence presented, I do not concur that the explanation for the unrealistic negative fall speeds shown in Figure 7 is necessarily the high variability of air velocity at the cloud top.
c) Furthermore: "The Doppler lidar does not show this effect, because it only shows measurements which are from a very restricted height level at cloud base " is a very indirect and potentially misleading way of saying that "The Doppler lidar does not show this effect because it does not penetrate to the cloud top in this case". (This is a minor comment).
d) Also the statement that "The Doppler lidar, however, operates with a smaller measurement interval (2 s), which explaines why several smaller updraft events are still visible after subtraction of the wind profiler data." Need to be better substantiated. If one were to filter in (slow) time the image on lower left panel of Figure 7 by a factor 5 to achieve what the lidar would have seen with a 10 s integration, would that look like the lower right panel? If that is the case, then the authors have a good point, but if that is not the case, then something else is contributing. Visual inspection of the image is not obviously suggesting one way or another to me. This needs to be much better substantiated.
e) And even if point d) above is better presented, the statement "This emphasizes the need for a Doppler lidar in order to record the fast-changing vertical motions at cloud base, where the vertical and temporal resolution of

both wind profiler and cloud radar are not sufficient." is also not warranted. Integration time and vertical resolution are not peculiar to lidar (vs. radar). There are plenty of radars that integrate much less than 2 seconds (e.g., the cited CloudSat integrates for 0.16 seconds, and, more relevant to this case, the ASR program by DoE has been operating Ka and W band vertically pointing radars at 1 second integration time with I believe a 30 m vertical resolution).

f) The value of having lidar and radar and profiler is not in discussion here, I do agree with the authors that such combination is extremely valuable, but their complementarity should not be emphasized in areas that are just matter of engineering: they should be emphasized in the physics that govern their very different wavelengths.
g) Minor: it would be really nice if the Heymsfield and Westbrook (2010) approach were applied to these data to make retrievals , and substantiate better this general aspect.

Figure 8: the SNR images as in Figure 5 should be shown. What is that remarkably horizontal band at 3300-3500 m in the lidar image? What is the explanation for that incredibly fast change in velocity in the radar image (the boundary where it swaps from dark green ~-0.75 to dark blue ~1.2 m/s in just one or two range bins? Completely different hydrometeors? The map of powers and decorrelations would help a lot. How can the authors tell that the red line transect shown in Figure 9 is the cloud base? Was this a two layer cloud deck? Where was the zero isotherm? There is really a lot of detail missing in this section that could be very interesting and would allow better understanding.

Minor comments:

Figure 2: would benefit of enlargement and or rearrangement of panels to make them more visible.

Typo: Explaines → explains

Figure 6 is a somewhat arbitrary selection of features of interest. For example it doesn't address at all the interesting patterns of up and downdrafts within the precipitation that the profiler and radar observe. Maybe in the text some summary of all things that can be addressed by these data would be beneficial to an interested reader.