“Towards improved turbulence estimation with Doppler wind lidar VAD scans” by Wildmann et al. provides an improved method to retrieve turbulent kinetic energy (TKE) and its dissipation rate using Doppler wind lidar VAD scans. The advantage of the new method is that it corrects also for the effects of advection, which is not included in the previous methods. This feature makes it possible to retrieve turbulent parameters also using higher elevation angles for the VAD scans, here 75º instead of the more commonly used 35.5º. The paper represents clear and thorough work to advance the measurement techniques using Doppler wind lidars and therefore is suitable for publication in AMT. However, before publication it requires major revision mainly due to one aspect in the methodology which has not been sufficiently discussed and which may have a substantial effect on the results.

Major comment:

The method to retrieve ε from sonic anemometer (and research aircraft) measurements is based on averaging 2 min estimates of ε over 30 min sampling time. Taking the average means that the distribution of ε_{2min} is assumed to be Gaussian, which is not necessarily true as the magnitude of ε_{2min} may vary over several scales of magnitude. When the distribution is not Gaussian, the average will introduce a bias to the ε_{30min} estimate. Therefore, authors should check the shape of the distribution of ε_{2min} values during each 30 min period and choose an estimate for ε_{30min} that is more representative for the distribution of ε_{2min} values, such as the median of these values.

Minor comments:

Abstract:
It is not obvious to all readers that “DLR Cessna Grand Caravan 208B” is a research aircraft, please, add this to the abstract. Further, it is not clear why do you introduce the research aircraft data in this study as the title is about improvement of turbulence estimation using Doppler wind lidars. For validation purposes research aircraft data cannot be considered as robust as sonic anemometer data. In fact, the explanation for using aircraft measurements is provided only in Section 5 on lines 8-9 of page 21. This explanation should be given already in the abstract but also in the Introduction (Section 1) and maybe also in Section 3.3.

Section 2, page 2, lines 33-34: “*data from two different sites and sets of instruments*”:
This is not clear: you use data from four DWLs (three in Upper Silesia, one at Falkenberg), from two sonic anemometers and from one research aircraft. Although you introduce the measurements in two Figures (Figures 1 and 2), it does not change the fact that you have several type of instruments and sites, not just two of each.

Section 2.1., page 3, line 19: remove “*and infrared gas analysers LI7500 (LiCor Inc.)*” because you do not use this data.

Section 2.2, the first two paragraphs on page 4: the description of the CoMet mission is too detailed and not relevant to the topic of this paper, as here the aim is not to investigate CO_2 or methane but to develop DWL data processing methods. Please, provide here only such information that is relevant for the present study.

Page 4, line 19: angle should read 35.5º not 35º.

Page 4, lines 20-21, 2 comments:

1. Check the tense of verbs to be consistent.
2. The acronyms of the Doppler lidars in Upper Silesia region are misleading: for the research aircraft you use the acronym “*DLR*” (e.g. in the abstract but also on line 8 of page 4) and for

Doppler lidars you have introduced the acronym "*DWL*". Why do you introduce here another acronym for DWL, i.e., "*DLR*"? Please, use only one acronym for Doppler wind lidars throughout the paper.

Page4, lines 23-25: "*a case study on 5 June 2017, on which D-FDLR was performing long straight and level legs between 800 m and 1600 m as indicated in the flight path in Fig. 2.*" This is the first time you introduce the research aircraft data and it is somewhat vague. Please, provide more information on why did you choose this data set, how did you select this specific period, what kind of instrumentation there was onboard, how accurate are the turbulence measurements from the aircraft in general, etc?

Page 6, line 7: "*the values are calculated for 2-minute intervals and then averaged over half-hour periods.*". Include here information about the distribution of values calculated for 2-minute intervals, to show that the average is (or is not) a representative parameter for the population of values (see also the major comment).

Page 7, line 19: Should it read Eq.2 instead of Eq.3?

Page 7, line 20: Why does ψ_l change to ψ_1 here? Please, explain what it means that l=1?

Page 7, line 25: Typo: "*Kolmogorov-Obhukov spectrum*"

Page 8, Equation (15): It is not clear how this Equation is derived from Eq. 13 and 8: what happens to σ_e^2 that was in Equation 8?

Page 9, line 8: "*In (Smalikho and Banakh, 2017)*" change to "*In Smalikho and Banakh (2017)*"

Page 10, Equation 20: There is no index j in the equation (which is included in the summation). Moreover, are there some parenthesis missing?

Page 12, Section 3.3: Again, it is not clear why research aircraft data is used: is it used a) because it gives more reliable results than DWLs and therefore can be used for validation of DWL data or b) is it used because it would be interesting to know how good the research aircraft data is compared to DWLs (and sonics)?

Page 14, Figure 5: It is not possible to see the dotted line in panel (a). Moreover, in the caption, could you provide the Equation numbers for the averaged variance and total variance methods in order to strengthen the link between the theory and the results.

Page 14, line 5: "*modified version W19 introduced in this study*", maybe you should use acronym W20 for the method introduced in this paper?

Page 15, Figure 6: Does the biases in (b) and (e) include all points or only those after the advection filter?

Page 17, Figure 8: Why there is an oscillatory pattern in TKE bias as a function of horizontal wind speed? The oscillatory pattern is more significant than the differences between the methods, and therefore it should be discussed. Could you also provide here the amount of data in each bin, maybe by adding another y-axis for that?

Page 18, line 9: "*Here, it shows that the difference between S17 and W19 only occurs at the very lowest level*" - this cannot really be seen from Figure 12.

Page 19, Figure 11: Another horizontal axis with a km scale would be nice, because in the text you give the length of the flight path in kilometers.

Page 20, Figure 12: Different DWL lines are extremely difficult to see in both panels. Consider using different colors for the lines and rescaling of the figures.

Page 20, lines 16-18: "*The advection effects are most relevant at the lowest measurement heights where the spatial separation of lidar beams along the VAD cone* Δy *are small.*" This is true, but what could perhaps be also mentioned is that the advection speed increases with height because of the logarithmic wind profile.

Page 21, lines 1-3: "*dissipation rates of values smaller than* 10^{-3} m^2s^{-3} *are underestimated by the lidars, likely because the small scale fluctuations that are carrying much of the energy in these cases, cannot be resolved any more.*" This can be true, but you should still check the method to retrieve dissipation rates from sonic anemometers as mentioned in the previous comments.

Page 21, lines 8-10: this information should be provided much earlier in the manuscript. This is not just a result but also the motivation to use research aircraft data in the first place.