Responses to reviewer 1

General comments and recommendation for disposition of the paper

This work presents an analysis on the observations made jointly by a Doppler lidar (DL) and a UHF band wind profiler radar (LQ7) in convective boundary layers (CBL) in clear air. The database was built during a measurement campaign lasting about one month. The research mainly uses the vertical profiles of the time series of the vertical air velocity W measured continuously by the two instruments. The information on the height Zi of the atmospheric boundary layer is deduced from the vertical reflectivity profiles of the LQ7 (local maximum of reflectivity). This important information is used in the discussions. As the title indicates, the authors focused the results on ε which represents the dissipation rate of the turbulent kinetic energy (TKE). It is a fundamental parameter in the description of the boundary layer. Given the role that W plays in the restitution of ε and in the demonstrations related to the inter-instrument comparison, it would be appropriate to include the vertical velocity in the title.

The difficulty of the comparison comes from the fact that the measurements of the two instruments do not overlap in altitude. The lidar produces observations below 300 m while the radar begins its usable observations from 400 m. The analysis then calls upon considerations of vertical continuity of W and ε and the known vertical evolution of ε in the CBLs. A true quantitative comparison remains to be made but from a qualitative point of view the results obtained are very convincing. The dissipation rate of the turbulent kinetic energy ε is obtained from W in two different ways. The first method (TS method) deduces ε from the spectral analysis of the time series of W under the assumption of Kolmogorov-Obukov inertial turbulence. The second method (DS method) which is the most commonly used in the literature uses the spectral variance σt2 of the Doppler spectral peaks caused by turbulence. This information is only known and recorded by the radar. As expected due to the low temporal resolution of the radar (more than 10 times lower than DL), the TS method applied to radar data turns out to be unreliable in comparison with DL retrieval. In fact the comparison of the ε obtained by DL with the TS method and by LQ7 with the DS method is the main objective of the work. The various results of this comparison show a good similarity between these two types of measurement. These results are optimized by using for LQ7 the law ε = σt3 ⁄ (α D). Where D is the thickness of the CBL and α is a parameter, comprised between 0.1 and 0.2, which depends on the physics of turbulence. This law, the formulation of which is found in the literature, remains empirical and needs further observations to be validated and in particular to quantify its uncertainty range.

The measurement of the lidar and radar has a spatial resolution that depends on the resolution volume as a function of the beam aperture and the pulse length. This induces a spatial filtering whose effect is mentioned but which is not taken into account here based on a rather weak justification. This filtering is taken into account in retrieval equations that can be found in the literature. The resolution volume is a parameter that differs greatly between the two instruments. It would therefore be important to evaluate the uncertainty brought by ignoring this filtering.

This well-structured document written in a clear and concise style is easy to read and understand. The demonstrations are supported by well-chosen graphs. The bibliography, which seems well up to date on the subject, shows that the authors are recognized specialists in the field covered. This work certainly convinces the reader of the interest of using a radar or a lidar for the measurement of the rate of dissipation of turbulent kinetic energy ε in the monitoring of CBLs in connection for example with atmospheric pollution problems.

In conclusion this paper which is well conducted and which presents a good scientific interest is appropriate for the publication in the journal Atmospheric Measurement Technique. However this recommendation is subordinated by the consideration by the authors of the previous major and following minor comments.

We thank the reviewer for the evaluation of our manuscript and for his positive assessment. We understand that the referee's primary concern is our lack of discussion regarding the effect of radar spatial filtering on the DS method. This is indeed a crucial aspect, which we address here in greater detail and have incorporated into the revised version of the manuscript.

Main review points

1) The technical description of the instruments in the document is brief, it is supplemented by bibliographical references. In order not to tire the reader too much in often tedious research, I suggest giving directly the essential operating parameters of the instruments: length and coding of the pulses, number, direction, and aperture of the beams used.... This would allow to quickly have an idea on the spatial resolution and to understand why the LQ7 has a first gate starting at 300 m while the given vertical resolution is 100 m.

We added a table with the specification of the two instruments.

	LQ7	DL
Operational frequency	1.375 GHz	194 THz (Wavelength: 1.543 µm)
2 ways half power half width (°)	2.1	
Beam directions (Az,Ze) (°)	(0,0), (0,14.2), (90,14.2), (180,14.2), (270, 14.2)	(0,0), (0,28), (90,28), (180,28), (270, 28)
Range resolution (m)	100	20
Number of gates	80	< 20
Altitude of the first gate (AGL)	300	40
Interpulse Period (μs)	100	0.33 (Shot frequency: 3000 Hz)
Acquisition time for one profile (s)	59	4
Acquisition time of the mean profile for routine measurements (min)	10	10
Velocity aliasing (ms^{-1})	10.8	44

Table 1: Main specifications of LQ7 and DL

2) The DS method uses the variance of the spectral Doppler peaks corrected for effects not related to atmospheric turbulence. It is important to list all of these extra-turbulent causes and to explain how the correction is made.

Following the suggestions of both reviewers, the methodology for applying the spectral width technique has been expanded by including an appendix.

3) Figure 1 shows that in addition to the vertical beam, the lidar has four oblique beams and the radar five. The authors have used only the vertical beam for the direct measurement of W. We can also use only the oblique beams to deduce W. When the components of the horizontal wind speed are far from the zero spectral line, the measurement of W will be less sensitive to the presence of ground echoes which are very penalizing at low levels (mainly for the radar). I would like to know if the authors have used this possibility and what advantages and disadvantages they found in it.

For the present study, we did not use the oblique beams to deduce *W*. We note the two independent estimates as follows:

$$W_{NS} = \frac{RN + RS}{2\cos(\alpha)}$$

$$W_{EW} = \frac{RE + RW}{2\cos(\alpha)}$$

Where $\alpha = 28°$ for DL and 14.2° for LQ7, and RN, RS, RE and RW are the radial velocities from North, South, East and West directions, respectively.
The first author considered this possibility with the MU radar for a climatology of frequency spectra in a recent paper (Luce, H., Nishi, N., & Hashiguchi, H. (2024). A climatological study of the frequency spectra of vertical winds from MU radar data (1987–2022). Journal of Geophysical Research: Atmospheres, 129, e2024JD041677. https://doi.org/10.1029/2024JD041677).

The wind speed near the surface remained consistently weak throughout the entire campaign, with values below a few meters per second, except for 06 September 2022, which is excluded from the statistical analysis. Comparisons between W, W_{NS}, and W_{EW} showed no significant differences across the dataset used in the manuscript. This suggests that ground clutter contamination was likely negligible in LQ7 data. In response to the reviewer's request, we present several figures comparing the three velocity estimates from LQ7 and DL and the corresponding spectra for the example days highlighted in the manuscript, specifically 27 August and 11 September 2022.
Figures R1a and R1b show the time series at 3-min time resolution of W, W_{NS}, and W_{EW} spanning from 07:00 LT to 17:00 LT on 27 Aug and 11 Sep , for LQ7 in the range 400-500 m and DL in the range 100-300 m. Figures R2a and R2b show the corresponding scatter plots of W *vs* W_{NS} (left panel), W *vs* W_{EW} (middle panel), W_{NS} *vs* W_{EW} (right panel) for DL (red) and LQ7 (black). The time series reveal no substantial outliers or biases. Scatter plots for DL and LQ7 on 11 September indicate greater dispersion for both instruments. This increased dispersion suggests that it is not solely attributable to estimation errors but also reflects real differences between the estimates, likely caused by the sampling of different volumes. The mean difference between W, W_{NS}, and W_{EW} varies between 0 to 4 cm/s for both instruments.

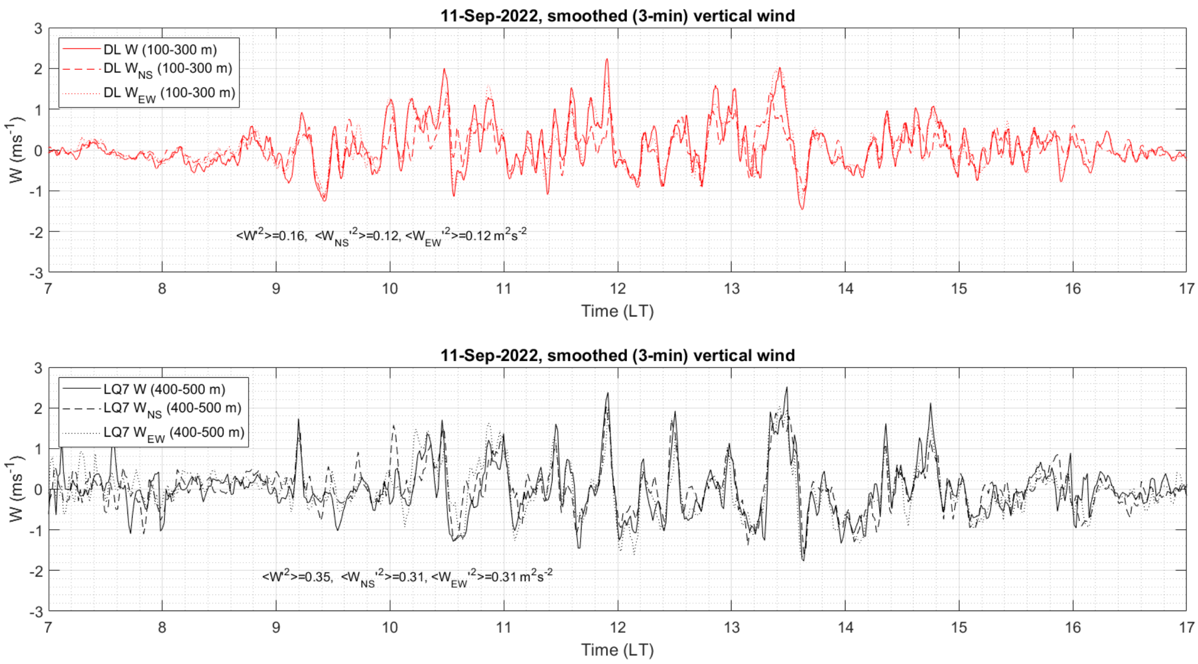

Figure R1a: Time series of vertical velocities W, W_{NS} and W_{EW} at a time resolution of 3 min between 07:00 LT and 17:00 LT on 11-SEP-2022 for DL (top) [100-300 m] and LQ7 (bottom) [400-500 m].

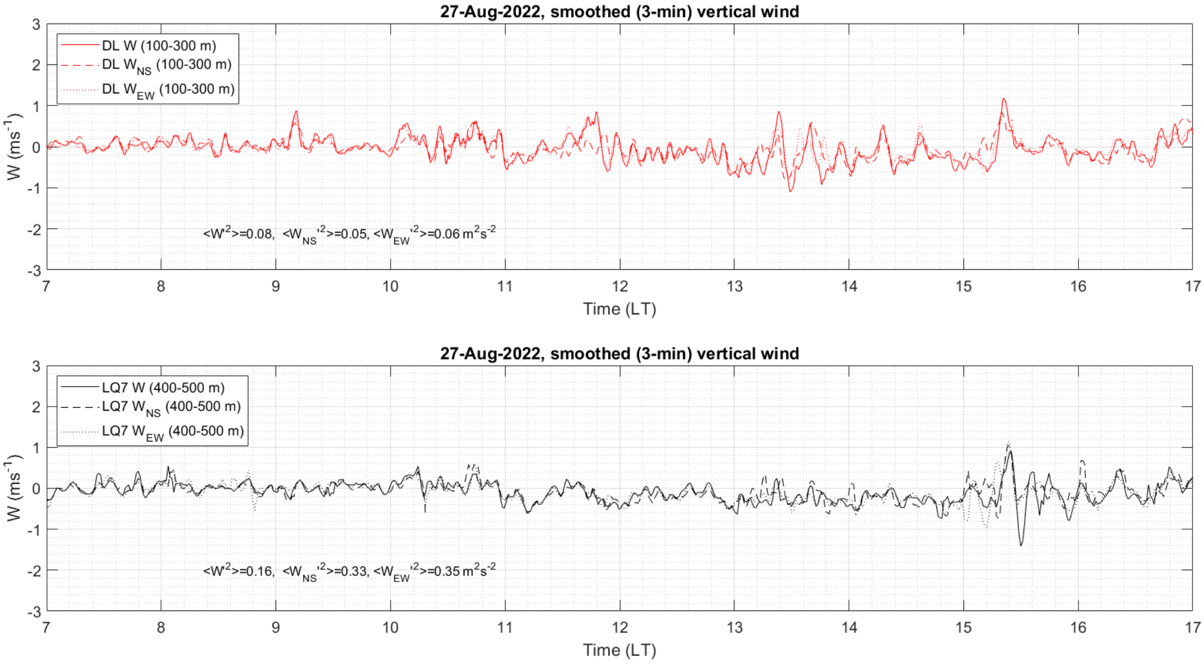

Figure R1b: Same as Fig R1a for 27-AUG-2022.

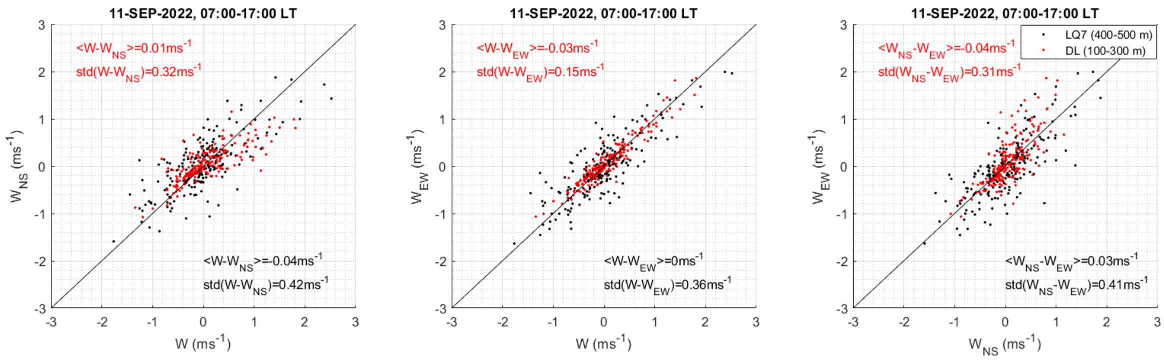

Figure R2a: Scatter plots of W vs W_{NS} (right), W vs W_{EW} (middle) and W_{EW} vs W_{NS} for the data shown in Fig. R1 on 11-SEP-2022 for DL (red) and LQ7 (black).

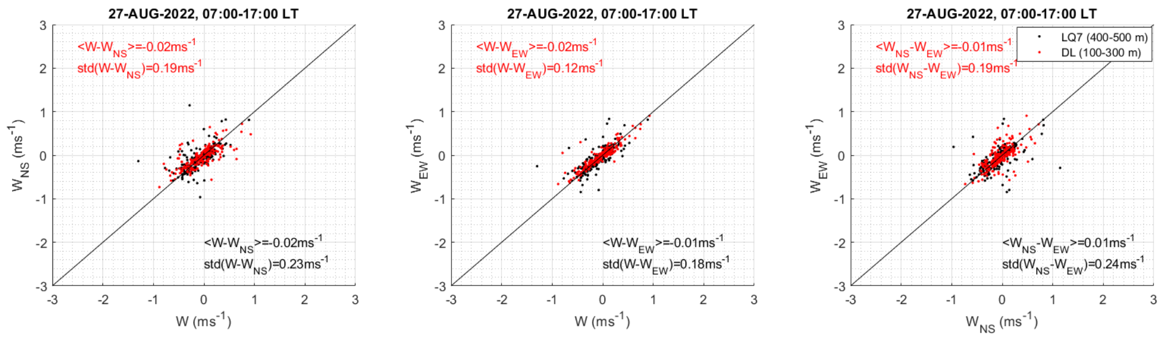

Figure R2b: Same as Fig R2a for 27-AUG-2022.

Figures R3a and R3b show the corresponding wavenumber or frequency spectra (blue from W, green from W_{NS}, and red from W_{EW}). They globally show the same shape at all frequencies or scales for both DL and LQ7. However, we have noted that the spectral levels of W_{NS} and W_{EW} are slightly lower than those of W for DL (on the order of 30% to 50% , Fig. R3b). The variances of the W_{NS} and W_{EW} time series from DL are also lower than the variance of W (Fig. R1a and R1b).

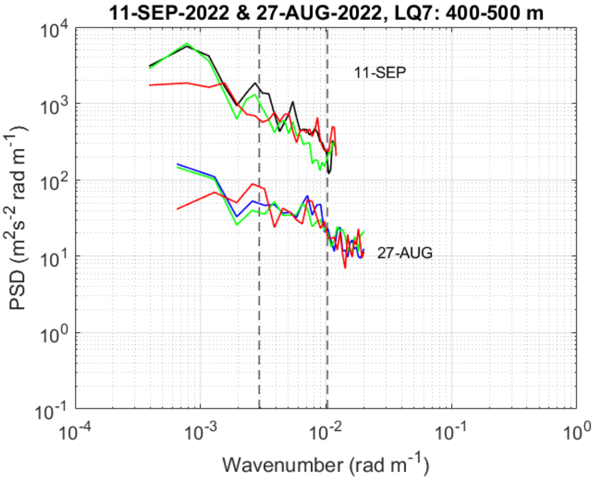

Figure R3a: Wavenumber spectra of W (blue), W_{NS} (green) and W_{EW} (red) from LQ7 data for 11-SEP-2022 and 27-AUG-2022.

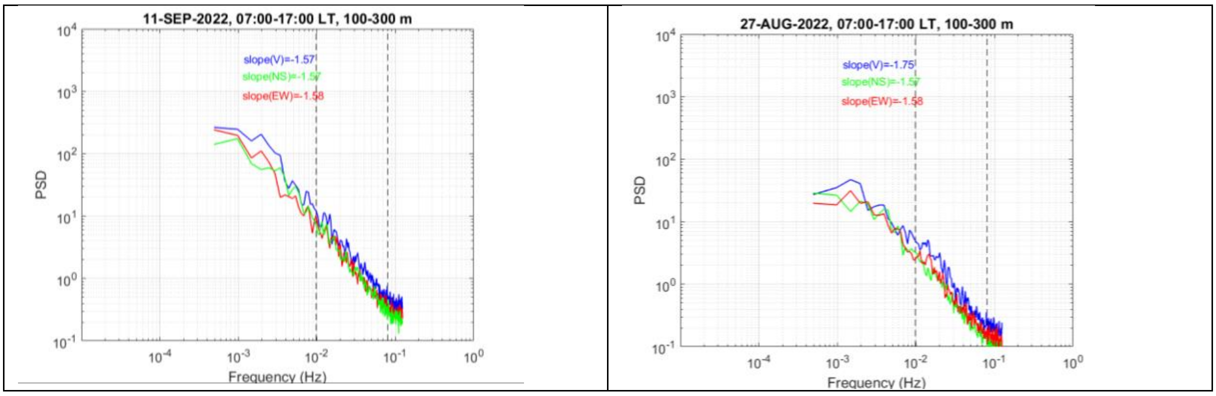

Figure R3b: Frequency spectra of W (blue), W_{NS} (green) and W_{EW} (red) from DL data for 11-SEP-2022 (left) and 27-AUG-2022 (right).

We suspect that this property may result from the sampling of different volumes in a horizontally inhomogeneous W field. This effect is likely more pronounced for DL due to its oblique beams being tilted 28° off zenith and its very narrow beam. Within the 100–300 m range, the horizontal distance between the lidar sampling volumes is approximately 100–300 m. Note that for LQ7, the corresponding horizontal distance within the 400–500 m range is approximately 110 m only (tilt angle of the beams=14.2°)

We made an elementary test by assuming a wave disturbance anomaly of W (to simulate updrafts and downdrafts within a CBL) of amplitude 1 m/s, with a period of 100 s and a horizontal wavelength of 1000 m at z=200 m. We assimilate the DL as a point measurement and we generated W time series from the vertical beam and the combination of the two pairs of oblique beams tilted 28° off zenith. The objective is not to produce realistic values but to get a qualitative result. The time series of measured and reconstructed W are shown in red and blue curves, respectively (Fig. R4). The reconstructed W amplitude is indeed attenuated by 20%. Therefore, W_{NS} and W_{EW} may be underestimated when the horizontal distance between the pairs of DL sampling volumes is not negligible compared to the horizontal scale of the W disturbance. This may represent a significant drawback when estimating energy parameters from W_{NS} and W_{EW}. More realistic simulations, coupled with a quantitative analysis of the time series, could provide valuable insights into the horizontal inhomogeneity of the vertical wind field.

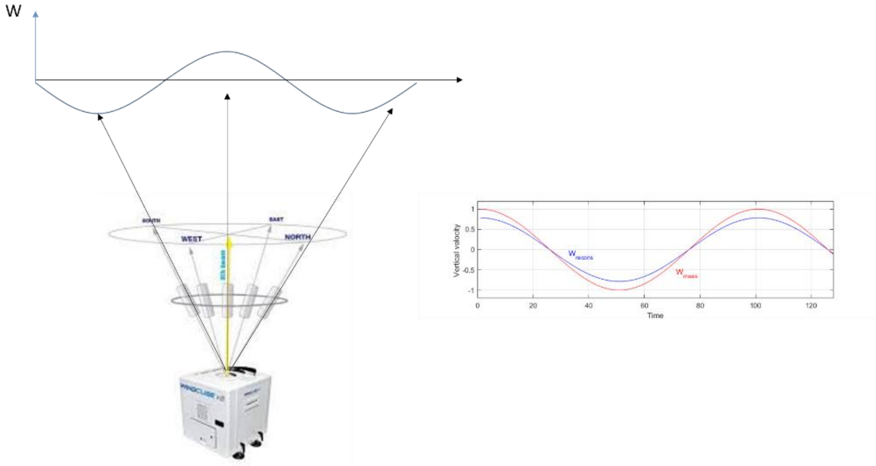

Figure R4: Schematic representation of the impact of the use of 2 oblique beams on W measurements

4) The study offers a database of vertical air speed observed by two different types of instruments of rare quality but which I find insufficiently exploited. This concerns in particular the problem of the negative bias of the average vertical speed in the CBL observed by the UHF band wind profiler radar since their beginning in the seventies. This negative bias can reach several -0.1 ms-1. Experimental and theoretical explanations have been put forward but to my knowledge without success and the problem remains. On the contrary in your work you deduce that this bias is almost zero for the UHF radar and also for the lidar. It is frustrating for an informed reader that you do not point out this contradiction with the numerous past observations. This paper would therefore benefit if you developed this particular point even if it does not fit into the main objective of the paper.

The reviewer seems to refer to results reported by e.g., Angevine (1997) and references therein. These results show a wind profiler produces a negative W bias (for unclear reasons) during CBL activity. The analysis we presented in the manuscript does not allow us to confirm or rule out the presence of such a bias in our dataset. It is limited to the daytime, partly because of birds or bats contaminations of the raw data during night time. If the bias is present, it would not affect our spectral analysis (because it has a diurnal time scale). For information only, we plotted the histograms of W(DL, 100-300 m) and W(LQ7, 400-500 m) measured between 07:00 LT and 17:00 LT for the whole period of the campaign (27 Aug – 15 Sep) in Fig. R4. The mean difference <W(LQ7)-W(DL)> is -10 cm/s. It is consistent with the possibility of a bias in LQ7 measurements, assuming that DL measurements are unbiased. (NB: Angevine (1997) suggested that radar is partly sensitive to suspended particles to explain the measurement bias. Lidar would undoubtedly be affected by the same bias, and comparisons would be unable to identify it.) Unfortunately, this difference must be interpreted with caution, as the two instruments do not sample in the same altitude range. Like the results we present in this manuscript, data covering the same altitude range should be obtained for more decisive analysis and conclusions.

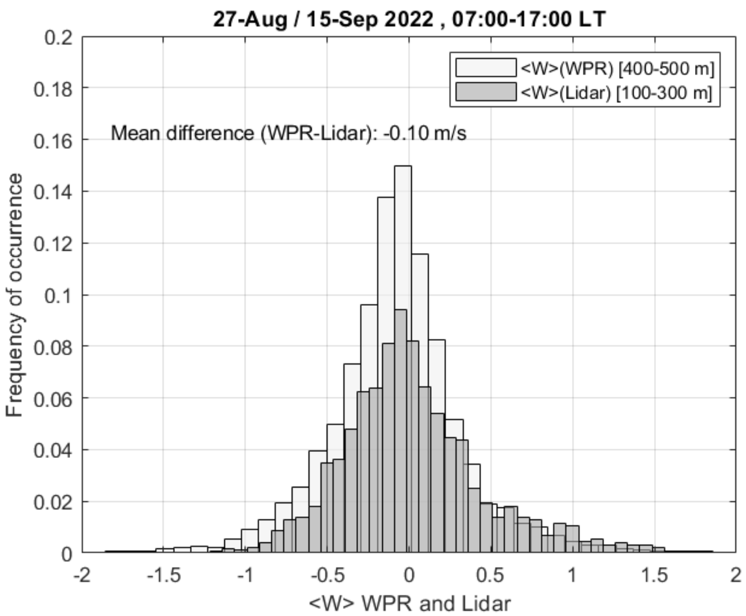

Figure R5: Histograms of W from LQ7 [400-500 m] and DL [100-300 m]using all the data from 27-AUG to 15-SEP-2022.

5) The localization of the height of the boundary layer Zi by a local maximum of the radar reflectivity is a method which if well conducted gives precise results. It is therefore not necessary to associate the word proxy with this radar Zi which in fact tends to discredit this measurement.

We removed the term “proxy”.

6) The observations that are discussed are located in the convective boundary layer. This is a dynamical and thermodynamic framework that is inefficient for the development and maintenance of gravity waves. It is therefore unwise to dwell on it too much.

The reviewer is right. We address this point in lines 465-466.

7) For figure 12 use log10 (ε DSLQ7 / εDL) instead of log10 (εDSLQ7)- log10 (εDL) in the caption and instead of Δ log10 (ε) on the horizontal axis.

We corrected the caption and label of figure 12