In the manuscript egusphere-2024-868, titled "Improving the Estimate of Higher Order Moments from Lidar Observations near the Top of the Convective Boundary Layer", the authors test a new approach of computing profiles of higher order moments and fluxes of atmospheric constituents. Higher order moment and flux profiles have been derived by a number of researchers from ground-based lidar observations and they are typically computed on a regular altitude grid in m above ground level. To reduce the sampling errors, higher-order moments and fluxes are normally averaged over a 1-hour time period. When the mixed layer height (zi) is changing rapidly (e.g., during the morning), a 1-hour window near the top of the mixed layer could encompass observations from both, the lower free troposphere and from within the boundary layer, leading to potential biases in the retrieved higher order moments and fluxes. To avoid this, the authors propose to compute the moments and fluxes on an altitude grid normalized by mixed layer height (z/zi), thereby guaranteeing that the data used for moment and flux calculations are completely from within or outside the mixed layer. The authors test the feasibility of this approach by running LES simulations over a 10 km x 10 km domain at the ARM SGP site. The domain-averaged higher order moment and flux profiles at each simulation time step are considered the truth and are compared to 1-hour time averaged moments and fluxes computed on a standard altitude grid and a normalized grid. The authors present convincing evidence that at 0.9 zi and above the moments and fluxes computed on the normalized grid consistently better match the domain averages than the moments and fluxes computed on the standard grid. The manuscript only contains results for a single day, but the authors state that they ran additional simulations, which produced similar results.

The manuscript is logically well organized and in general written clearly and concisely. The conclusions presented in the manuscript are supported by the data. Tables and figures are all necessary, and the topic of the paper fits well within the scope of AMT. **I recommend publication after minor revisions.**

Comments (suggested changes in bold):

Line 25: "Wulfmeyer et al (2016)" is repeated.

Line 47: "… **restrict** the analysis …"

Figure1, caption: "… from the slab values (**black**), … of the single column (**orange**)."

Line 56: "… the overbar **indicates** a temporal …"

Line 64: Specify the time step of the LES simulation. It is mentioned in the caption of Fig. 1 ("… instantaneous 10-s values…"), but also spell it out here.

Line 65: "… time series **at** a single location …"

Line 72: Specify the degree of the smoothing polynomial of the Savitzky-Golay filter function. A filter window of 1 hour is mentioned here, but the Fig.1 caption states a 30-min temporal average. Please reconcile.

Line 75: "… cross sections of variance, skewness, **and kurtosis** of water vapor …"

Lines 75-79: State here over which time window the higher order moments and fluxes are averaged. Fig. 2, 4, 6 captions mention "1-h period centered on each 30-min", so I assume the averaging window is 1 hour. Are the moment and flux data produced at the original 10-s resolution by averaging over 1 hour in a gliding fashion? The slab values are available at 10-s resolution. The q variance, skewness, and flux line plots in Figs. 8-10 are plotted at a resolution coarser than 10 s. What is the moment and flux time resolution?

Line 79: What is the z^ grid resolution?

Line 90: "… of the variance, skewness, **and kurtosis** than using …"

Lines 90-91: Discuss briefly the error contribution of interpolating the time series data onto the z^ grid and interpolating the higher order moment and flux profiles back onto the z grid for comparison purposes.

Line 92: **3. Results**

Lines 93-94: … are **the** truth to which …"

Lines 96-98: "… but the normalized z^ grid has less of a gap just before 1500 CDT while the regular grid has a more significant gap there. This tells us that the normalized z^ grid captures the variance better than the regular grid." The differences between the regular and normalized grid q variances appear so small, that this statement is not justified based on the data shown in Fig. 2. Fig. 8 quantifies the slight improvement at 0.9 and 1.0 zi that is gained by using a normalized grid. Reserve the statement about which grid type better captures the true q variance until after Figs. 2, 3, 8, and Table 2, 3 have been discussed.

Line 98: It seems Fig. 3a and 3b are exactly identical. Do they both show 2c – 2a?

Line 99: "… values **except at** 12:30 CDT …"

Lines 111-113: "… that both methods match ~~**with**~~ the slab values **quite well** in the early morning and in the late afternoon, but not ~~**as much**~~ from 1000-1730 CDT, except for right along the top of the boundary layer.~~**, where it is very close to the slab values**~~

Line 116: State more clearly that RMSE refers to the RMSE of the difference between the grid and slab values.

Lines 121-122: "… at the flux (Figure 10), **the normalized z^ grid method yields slightly smaller RMSE values at 90% of the boundary layer (Figure 10a) and at the top of the boundary layer (Figure 10b).**

Lines 126-127: "In these tables, **lower values are bolded ~~by the standard error of the two or more are bolded to show the better value.~~**"

Line 128: "… or the values were better for an equal number of calculations …" Unclear what the authors mean by that.

Line 131: "… except w **variance**, where the methods **yield the same RMSE.**

Lines 131-132: Finally, at the top of the boundary layer (Table 3), the normalized z^grid method is better in all cases. **~~except q variance, where the methods are the same.~~** Fig. 8b shows that normalized RMSE is lower (0.391) than regular RMSE (0.403). It appears that the former value has not been entered correctly into Table 3.

Lines 132-133: "At every height, the normalized z^ grid method was better for q skewness." This is also true for w skewness, w kurtosis, and both fluxes.

Line 135: **4. Discussion**

Lines 147-148: "…we must remember **that a single column will never be able to properly capture the spatial variability because of sampling errors**. It is clear, especially in the **q variance and q flux time height cross sections** around 1230 CDT…"

Line 150: **5. Conclusions**

Line 153: "… to the higher order moments **and fluxes** derived …"

Figures and Tables:

Group all three tables together after Fig. 10.
Q flux unit: (gkg^-1) (ms^-1)
T flux unit: (K) (ms^-1)
Bold z^ RMSE values for w variance and w skewness in Table 1.
I gather that the line plots in Figs. 8-10 are extracted from the time-height cross sections that are all ona regular grid (see Figs 2, 4, 6). Do the line plots represent data at the regular grid height that is closest to 0.9/1.0 zi?

References:

Lines 198-199: Lenschow et al. (2000) is cited incorrectly. Substitute with:
“Lenschow, D. H., Wulfmeyer, V., and Senff, C.: **Measuring second- through fourth-order moments in noisy data.,** J. Atmos. Oceanic Technol., 17, 1330–1347, https://doi.org/10.1175/1520-0426(2000)017<1330:MSTFOM>2.0.CO;2., 2000.”