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Reviewer CFairall Comment on acp-2022-59

Christopher Fairall (Referee)

Referee comment on "Momentum fluxes from airborne wind measurements in three cumulus cases over land" by Ada Mariska Koning et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-59-RC2, 2022

This paper is a description of a dual aircraft observations of cloudy boundary layers in Germany. One aircraft made turbulence and mean profiles and the other overflew the first aircraft with a down-looking profiling Doppler wind lidar (DWL). The DWL used the VAD method processed in legs of 7 km length and about 2 km width. The flights were made on three days with quite different cloud properties but broken convective cloud were the dominant mode. The analysis includes scale dependence of the fluxes, flux-gradient relationships, updraft portioning, and turbulence distributions.

The paper is well reasonably written; the introduction section is thorough and well referenced and does a good job of setting the stage. Dual aircraft studies of this type are unusual and the DWL wind profiles are of high quality and add significant value to interpretation of flux profiles. The conditions are so different on each day (indeed, almost on each segment) that the results cannot really be combined – they serve mostly to indicate how different turbulent transport can vary with cloud mode. So the paper provides little closure – it is mostly in the vein of "On this day the clouds were like this and the profiles were like this, whereas on this day…". The various descriptors are somewhat convoluted (subcloud, east track, clear sky, etc) that I found it difficult to synthesize anything. I am not an expert in convective theory or analysis so perhaps the results speak volumes to those practitioners. Because the paper shows the potential of this observation technique and the results show amusing variability that suggest a larger, more systematic study, I recommend the paper be published. I have a few minor editorial suggestions listed below.

Figure 2 would be more illuminating to turbulence people is the streamwise, cross stream, and vertical spectral components were presented on the same graph. Perhaps a 4-panel

figure with a panel for a different height. Also, suggest plotting frequency*Spectrum to be area conserving in log-log space.

*Computation of fluxes via eq 1 is equivalent sampling the time series with a square window, computed the cospectra, and integrating that to get <w'x'>. The authors use Hann window for their variance spectra, which has advantages over the square window. I suggest they use Hann or Hamming window for flux computation. This will reduce leakage from lower frequencies.

*Eq 2 introduces the K coefficient but the authors don't do anything with it except to say fluxes tend to be down gradient. I would not mind seeing some values and relationship to sigma_w and/or the scale associated with the peak of the vertical velocity spectrum.

*I did not find Figs. 10 and 11 to be that helpful. Perhaps they could be dropped.