

This manuscript combines surface and radiosonde observations of the atmospheric boundary layer (ABL) with large eddy simulation (LES) experiments to investigate the role of surface heterogeneity on the dynamics and thermodynamics of the ABL at a variety of spatial scales. The topic is interesting and timely for the ABL community, and the manuscript presents some interesting results, particularly on the interplay of advection and entrainment processes in shaping the ABL. However, I find the manuscript to be poorly structured and poorly written to the extent it makes it difficult for the reader to follow (some suggestions below). I highly recommend a major overhaul to the structure/writing. I also have some technical comments that I am hoping would help improve the manuscript.

- 1) Figure 2: The authors correctly discuss that the upper part of the ABL above the wet surface (Alfalfa) becomes drier due to advection or entrainment in the early afternoon. However, given that the temperature profile in this part still shows a colder ABL, does this suggest that advection is the main reason? Ideally, free tropospheric air would be drier and warmer than the ABL air, so entrainment would dry and warm the ABL. Given the wide range of uncertainty in the figure (shaded regions), it may be worthwhile conditioning this analysis on horizontal wind speeds to characterize advection.
- 2) Figure 3: the buoyancy flux near the surface seems smaller than the kinematic heat flux, on average. Is this just a visual issue. This needs explanation.
- 3) Line 178-179: This is a technical comment on turbulence isotropy. I suppose the authors mean component wise isotropy not turbulence isotropy, because the variances $\overline{u'^2}$, $\overline{v'^2}$, and $\overline{w'^2}$ can be equal and turbulence remains anisotropic in the Kolmogorov sense. Also, the units of the variances are $\text{m}^2 \text{s}^{-2}$ not s^{-1}
- 4) Line 297 and Figure 6: It is difficult to make sense of the fact that the variability in z_i within a patch (irrigated vs. non irrigated) is larger than the mean difference between the patches. Can the authors show the map of surface fluxes prescribed in LES? Are these fluxes homogeneous over a patch? This may hold some clues.
- 5) Line 202: The text refers to potential temperature θ' and the figure (4) shows absolute temperature T . Which is it?
- 6) Figure 4: Given the Primes are defined as fluctuations around the full transect, shouldn't the sum of T' averaged over the wet and dry areas be zero? Similarly for uTKE. The horizontal green and yellow lines do not seem like it.
- 7) Line 385: what is meant by "counter-gradient flux" in this context? This is not clear unless the temperature and humidity profiles are themselves shown.

- 8) Figure 10: stronger TKE pockets over the dry region (right part of domain) are accompanied with higher latent heat fluxes over that region, which is interesting. I don't see this discussed well, particularly in the context of a secondary circulation.
- 9) Figure 11: A blending height of $0.8z_i$ (wet landscape) means that there is effectively no blending (i.e., heterogeneity effects reach far up in the ABL). Also, the difference in blending height between temperature and humidity in Fig. 11a (Alfalfa) is puzzling. Even if these have some sort of transport dissimilarity as the authors argue, such a big difference suggests that some physical mechanism is at play that was not discussed, or perhaps a consequence of the method the authors use to estimate blending height?
- 10) Abstract Lines 9 and 10: "near 1000 m" and "~500m" are vague. Please clarify whether these represent horizontal scales or heights in the ABL.
- 11) Abstract Line 11: I suggest replacing "three-dimensionality of LES" with "spatio-temporal extent of LES"
- 12) Line 47: "aggregating the land surface properties"
- 13) Line 93: "Fig. 1 shows ..."
- 14) Line 126: replace "... temperature and humidity in a profile" with "temperature and humidity profiles".
- 15) Line 145: "we observe ...". This sentence is unclear; consider revising.
- 16) Line 283: remove "at"
- 17) Line 290: Fig. 7 not 7 7
- 18) Line 301: K/hr
- 19) Line 303: add a period after scales.