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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Surface heterogeneity impacts on boundary layer dynamics via energy balance partitioning" *by* N. A. Brunsell et al.

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The manuscript presents a study on the influence of surface heterogeneity on surface energy fluxes and boundary layer dynamics. The research is based on advanced numerical methods, LES simulation of atmospheric boundary layer flow and modification of surface properties via wavelet transform. I found it very interesting with thorough introduction as well as numerous results presented. However, the manuscript is also difficult to follow, especially for those who do not know the fine details of these methods. The authors have already responded in an interactive comment to a reviewer #1 that LES model description will be included in final manuscript. This certainly helps to improve the manuscript. I have one major concern and some minor comments. The manuscript certainly deserves publication after authors address these issues.

In a general view the results of the manuscript are determined by boundary conditions. The main result of the study in my view is Fig. 6, which indicates increase in latent heat flux over surface as modified by band-pass filtered surface conditions with dominant length scales 200, 1600 and 12 800 m. I think it deserves attention in abstract that the increase in latent heat flux was very large with approximately 50 W m-2. As the scale of heterogeneity was shown to have such a significant effect, I miss some links and understanding what was physical driver for such a significant change. Here more detailed questions follow related to my main concern.

1. P. 17824, l. 3 explains that wavelet multi-resolution analysis was performed on fractional vegetation cover, surface temperature and surface soil moisture. I understand that band-pass filtered fractional vegetation cover served as lower boundary condition for LES simulations whereas surface temperature and moisture only as initial conditions because those should be variables predicted by model at following times?

2. Description of wavelet multi-resolution analysis could be improved. There are several small questions such as: Why symbol t is use to denote space (usually used for time) and does it mean here a vector of co-ordinates on plane?; Wavelet transform was presumably performed on 2D but it is difficult to follow up provided description and notation used; Integration domain in eq. (3) was in practice limited to domain and not to infinity.

3. Result on p. 17825, l. 13-16 and Fig. 3. It is not clear what is concluded about the behaviour of surface temperature and moisture, were they concluded to be similar or not? Plots (d) and (h) of Fig. 3: It is not obvious how the result for soil temperature and moisture band-pass filtered case 12 800 m becomes so symmetic in x as well as y directions. Could the result include also the effect of limited domain (as in this case filter length is of the same order as model domain) and/or periodic boundary conditions? If the limited model domain can have effect on results, how much could it affect the main result i.e. observation of elevated area-averaged latent heat flux?

4. Fig. 6. I would like to understand the energy balance considerations. Fig. 6, (a) – (c) allow to infer that net radiation is not balanced by turbulent energy fluxes. Is it non-steady component (which probably can not be so large) or advection closing the energy balance? Advection should not be the case as the periodic boundary conditions should not allow that?

5. P. 17825, l. 15 onwards regarding elevated latent heat fluxes and and physical reasons for increase in LE. It is such a significant increase that deserves detailed attention. LE is driven mainly by transpiration i.e. leaf area as represented by parameter NDVI. Did band-pass filtering (i.e. wavelet transform and de-composition) of fractional vegetation cover with different scales used in manuscript preserve actually total vegetated area responsible for transpiration?

6. As a suggestion to understand underlaying physics maybe it is helpful to look in detail the starting period of simulation (e.g. "zoomed“ version of Fig. 6 around simulation start) where transition from initial conditions to semi-steady model conditions occurs.

Other comments

7. P. 17829, l. 5-7, it is concluded that scale of surface heterogeneity has no impact on the structure of the turbulent flow within the boundary layer. In introduction it is referred that previous studies (P. 17817, l. 21 further) have observed relation of boundary layer dynamics (circulation pattern, mesoscale circulation) to surface patchiness. How do you explain the result? Was it due to particular filter scales selected?

8. P. 17816, l. 11-12 in abstract. It would allow to understand that difference in boundary layer dynamics was observed. Please be more specific otherwise the sentence is in contradiction with result referred in my previous comment.

9. P. 17816, l. 19-20 in abstract. More homogeneous conditions tend to maximize latent heat flux: This is not true for the case with filter scale 1600 m. Thus it seems to be more complicated interaction of scales. Point this out.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 17815, 2010.