Review of

The influence of idealized surface heterogeneity on virtual turbulent flux measurements

by

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General comments:

This paper is successful in demonstrating the following conclusions: (i) in heterogeneous conditions in the kilometer scale, there is a clear relation between energy budget components and the location of the tower; this relation is less pronounced in the hectometer scale. (ii) In between patches of different surface heat flux, the energy imbalance is larger than in the center of patches. (ii) Storage is less important for the energy imbalance than advection and flux-divergence. (iv) Both advection and flux-divergence correlate well with the energy budget residual, therefore only one of them is needed to explain the residual. (v) In the kilometer scale, the advection is negatively correlated to flux-divergence variation; in the hectometer scale, it is positively correlated.

Although I don't think any of the three major suggestions I mentioned in my previous review were satisfactorily done, namely (i) a thorough discussion of simulation results, (ii) a correction of the correlation analysis, and (iii) a proposition of a model that could be useful in field experiments, I understand that they are more suggestions than corrections, so you should only take the suggestions you see fit. I believe the manuscript now has most of the information needed to sustain the aforementioned conclusions and only need minor revisions, although I still believe that better analyses would increase the impact of the manuscript significantly. The topic is important and the simulations are very interesting, but the choices of data analysis and presentation could be improved. Nevertheless, they are enough to reach the conclusions.

Specific comments:

1. PCA analysis: you still have not mentioned how many and which variables were used, and if there was any data preparation for the analysis (such as normalization). The manuscript needs to provide all the information necessary to reproduce the work.

2. PCA results: I personally cannot extract any conclusive information from this section. I understand that the biplot can be done even if the variance explained is only 60%, but I still think this is not the best choice of analysis. The fact that the third PC is almost as important as the second tells me that this biplot is a poor choice, as conclusions could change significantly if the third dimension was included. Considering that there are so many options of statistical analysis, I don't understand why using this one. All the conclusions I mentioned above do not depend on the PCA analysis, so it could be removed.

3. Simulation results: if I understood correctly, you varied the amplitude and the length scale of the heterogeneity resulting in 144 different simulations, but you combined all of them together in your statistics, looking at tower location as the independent variable. This is the reason for the large error bars in Figures 3 and 5, correct? So, why didn't you look into how these two variables (amplitude and length scale) affected your results? Why perform so many simulations? Would the results and conclusions be different if you looked into a smaller set of amplitude and length scale?

4. Is the homogeneous control run also lumped together with everything else in Figures 3-6? Some comparison between homogeneous and heterogeneous cases would be important too.

5. Figures 3 and 5: "That is, we averaged over the data with different time stamps and also over all cases corresponding to the intermediate length scales formed by the choice of surface flux amplitude and length scale." I don't understand this sentence. What intermediate length scales? What choice of surface flux amplitude and length scale? I understood that each data point is a combination of 144 cases, all at the same location independent of the value of surface flux at that location. "The towers are ordered according to the available energy at their location, for our model setup the available energy is equal to the surface flux." you mean "ordered" in the x-axis? Is it the relative or absolute value of the available energy at their location? The use of the "scaled available energy" as the abscissa is to represent the relative location of updraft/downdraft? I am assuming this from the discussion in paragraph 2 of section 3.2, but it is not really clear. Please clarify how the plot was constructed, and justify the choice of variable for the abscissa.

Suggestions:

1. Simulation results: I believe it would be useful to see how the variables of the simulation, for example, velocity, temperature, heat flux, advection, flux divergence, look like as a function of height and how do they vary as a function of horizontal directions due to the heterogeneity. I believe that seeing and discussing the physics of the flow and how these variables behave in the spatial domain could help us visualize what is happening physically. Performing LES is a great opportunity to look into these things that we don't have in field experiments. This is a minor suggestion that I believe would help to interpret the statistics better.

2. Equation (3): a sketch of the fluxes and a figure showing where in the 50 by 50m box each term is being calculated would be useful. Another way to avoid copywrite issues is to make a figure yourself. Just a suggestion.

1 Technical comments:

- Could you add the ranges of surface flux and u_* in Tables 2 and 3?