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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Integrating canopy and large-scale atmospheric effects in convective boundary-layer dynamics during CHATS experiment" *by* Metodija M. Shapkalijevski et al.

Anonymous Referee #1

Received and published: 31 October 2016

This manuscript describes the inclusion of a model for the roughness sublayer into a column model. Results are compared to observations during the CHATS experiment, during which largescale effects on quantities of the ABL were of importance. Overall, the results of the manuscript appear to be valid and of interest to the readership of ACP. I therefore recommend publication of the manuscript pending the revisions and comments outlined below.

General comments:

There seems to be a systematic problem with the fluxes as compared to the EC method, which deserves some additional discussion (see specific comments) to strengthen the overall results of the paper.

Both days discussed in this manuscript have strong influence of largescale processes, which are difficult to quantify (and allow for adjusting of results to measurements). The paper would be greatly strengthened. In my opinion, while this shows that the model can be used for realistic conditions, the paper would be greatly strengthened by including an ideal day with no largescale forcing.

In general, some of the figures should be enhanced to improve legibility (fontsizes, and line thickness)

Specific comments:

P1 L26: The atmospheric boundary layer (ABL), as a part of the global climate, is a dynamic system that is highly dependent . . . –> The ABL may be part of the climate system, but is in my opinion not climate itself. Please rephrase

P2 L5: These structures are responsible for most of the momentum (70%) and turbulent kinetic energy (90 %) exchange between canopy and atmosphere Fininnigan, 2000; Finnigan et al., 2009) –> these numbers are in my opinion not generalizable, please substitute with a more general formulation (e.g. majority).

P2 L30: Extending these previous works, our study aimed to elucidate the ABL system for real conditions, taking the representation of the RSL into account. –> This sounds a bit clumsy

Introduction: since the work is about the effects of the RSL, it would be good to provide the reader with some estimate of the vertical extent of the RSL, in which MOST does not apply. This could be order of canopy heights or some scaling with respect to u*, LAI, hc

Figure 1: please make sure that all variables are explained in the caption. I find the use of hc for canopy height and h for MLH confusing. I assume that there is a temporal component in that Figure as the ABL grows from left to right. Please explain this as well in the caption. Also, it would be good if the text would mention before the Figure,

what are the variables that are actually predicted by the model

P6 L3: please provide equation for c_d, since this is the variable affecting L_c. Also, could you provide some information about the choice of a(z) = const. How much of a difference does this make?

P7 L21: We used the observations at the highest measurement level at the tower (29 m above ground surface) to evaluate the model results away from the canopy, where the RSL effects are minimal.–> Please justify and compare to likely RSL height. 29m is probably not representative of the MLH as a whole. I understand in the absence of profiles, compromises have to be made, but they should be articulated.

P8 L8: Figure 2a,b shows the observed and modelled components of the net radiation: downwelling (âĘŞ) and upwelling (âĘŚ) shortwave (SW)... –> This may be a good time to remind the reader how fluxes are modeled, as this if important to assess the difference between EC and model

Figure 3 and associated text: It is well know that EC leaves fluxes unclosed. However, I have two comments based on Figure 2 and 3. (1) Please switch the axes in Figure 3 as it is commonly done. (2) In forest canopies energy and moisture storage inside the canopy can play a role on the diurnal scale. So that EB closure should also be looked at as the daily integral of fluxes (unless storage is other wise accounted for). Also, Modeled fluxes seem to be systematically worse in the afternoon. Is there a reason for this?

P11 L19: Both C_M and |U|are altered in opposite directions, with magnitudes that fit the observation (Fig. 6a,b), thus leading to a relatively constant u* –> This behavior is not obvious to me from the methods section, please give some information about the mechanism and also please comment on the impact of the apparent difference between observed and modeled u*.

Figure 7 and associated text: Please provide some interpretation of the meaning of

this findings

P13 L22-25: In the absence of detailed observations of the temporal evolution at the entrainment zone, we are able to provide only first order estimates of the large scale effects relevant to our cases and discuss their impacts on the budgets of potential temperature and specific humidity (Fig. 10). –> See general comment about large-scale effects. In my opinion this is a limitation of the manuscript as these conditions can be used to make things work and warrants some discussion by the authors.

Figure 9b+10b: I find the sensitivity analysis for fluxes a bit confusing, given the fact that I don't know from the methods how these are related. If I understand the methods correctly, then the effect of beta and Lc on fluxes purely arises from changes in the displacement height. Or are there other effects at play.

P15 L9-11: However, due to compensation between the drag coefficients and the differences in the mean variables at two levels within the roughness sublayer, the modelled surface momentum and heat fluxes remain relatively unchanged (< 3 %). –> A similar argument probably applies to other fluxes. A critical reviewer might raise the question, what the advantage of the RSL formulation is, if it has little effect on the MLH and on fluxes (due to compensation of terms). I suggest that the authors add a sentence or two to explain why the RSL formulation matters based on the results presented.

Technical (not necessarily complete):

P7 L11: specific moments / a specific moment?

Figure 2: Please increase fontsize in figure

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