

Interactive comment on “Role of the residual layer and large-scale subsidence on the development and evolution of the convective boundary layer” by E. Blay-Carreras et al.

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First of all, we would like to acknowledge the positive review and his comments that help to largely improve the manuscript. Below we answer all the comments made by the referee.

Referee 1 comments

1. The heart of the paper is the comparison of simulations initialized with two different profiles, with (RL) and without (nRL) a residual layer. The profile without a residual layer has considerably less total heat than the residual layer profile. After the BL grows

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to nearly its final height, the nRL simulation must necessarily have a lower temperature. This is not really a flaw in the design, but it must be taken into account when interpreting the results. For example, the first paragraph of section 3.3 should be reconsidered with this in mind.

We do not know if the referee has misspelled the comment. Obviously, the nRL numerical experiment has larger temperature for most of the day. Through a budget analysis, taking into account that the same amount of heat is introduced in the mixed layer at the surface, temperature is larger mainly due to the lower boundary layer height simulated for the nRL cases (see figure 5) and larger entrainment heat flux (see figure 6). We have clarified this fact in the new version of the manuscript.

2. p.31536 line 20ff: It would be helpful to show profiles just before and just after the residual layer is incorporated. These are shown in figure 4, but not called out as such, and forward referencing is generally not allowed.

We have changed the order of section 3.1 and 3.3 in the new version of the paper. Therefore, we can call out the figure at p.31536 line 20 because it is already incorporated.

3. p.31538 line 8: The roughly constant BL depth in the afternoon may be partly due to subsidence, but since the mean BL temperature also is roughly constant, advection cannot be ruled out.

We do not agree with the referee. As it is clearly shown in figure 4 (old figure 2), the observed potential temperature in the BL decreases during the afternoon. Cold heat advection could exist during the analyzed day, but its influence is small or it is only acting during late afternoon because without including its contribution we are able to approximately reproduce the observed temperature.

4. last paragraph of section 3.3: The interpretation is unclear here. The incorporation of the residual layer and the increase in magnitude of heat flux are not (cannot

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be) simultaneous. While the residual layer is being incorporated, the BL is in a "free encroachment" regime and the entrainment heat flux must be nearly zero because the temperature jump is zero. After the BL reaches the RL top, the jump is re-established and the flux takes on a new value. This could be shown by including the BL top trace on figure 5.

We have included in figure 6 (old figure 5) a line, which shows the evolution of the entrainment heat flux at the top of the RL before the merging with the CBL. Moreover, we have included new sentences accordingly.

5. Related to the previous comment, the authors rely on eq. 2 for much of their interpretation. They should keep in mind that the two terms interact and compensate. A large jump should lead to a small growth rate, for example.

We agree with the referee. The sentence has been modified accordingly.

6. A note on language: I prefer that authors express themselves in their own voice as much as possible. While some of the English in this paper is imperfect, I found it clearly understandable throughout.

We have reduced the passive voice in the new version of the article.

Specific comments:

1. p.31537 line 15: The main reason that the effect of subsidence can only be appreciated at the end of the afternoon is that its effect is cumulative.

We have modified the sentence.

2. Figure 3: It should be noted that the determination of z from the first sounding is erroneous, the analyst or algorithm has mistaken the residual layer top for the BL top.

We have changed the color of the point to avoid confusions in the analysis of the figure. Moreover, we have included a comment in the caption of this figure (new figure 5).

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3. p.31546, line 19: The winds are mentioned here for the first time. Because shear is important to entrainment, wind profiles (initial and at other important times) should be included in table 1 and added to the appropriate figures.

We already described in section 2.2 the initial and geostrophic wind characteristics. Nevertheless, we agree with the referee and we have included the information about the initial wind characteristics in Table 1 and in the new Fig. 2. Moreover, in the new version, when TKE is analyzed the role of wind shear is also discussed.

However, it is important to note that, taking into account that DALES numerical experiments do not include real topography of the site, it is almost impossible the numerical simulations are able to fit the observed values of the wind speed or direction because on the day under study the dynamics of the atmosphere was dominated by synoptic processes, such as mountain-valley flows (mesoscale conditions).

Technical corrections:

1. Abstract, line 19: "buoyancy heat flux" should be either buoyancy flux or heat flux.

The referee is right. We have avoided the use of buoyancy heat flux in the new version.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 31527, 2013.

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