

Geosci. Model Dev. Discuss., author comment AC1  
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## Reply on RC1

Wim C. de Rooy et al.

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Author comment on "Model development in practice: a comprehensive update to the boundary layer schemes in HARMONIE-AROME cycle 40" by Wim C. de Rooy et al., Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-184-AC1>, 2021

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Reply to reviewer 1 of gmd-2021-184

We thank reviewer 1 for the positive words and the useful comments and recommendations, which helped to substantially improve the paper. Below we describe how we addressed your specific points. Hopefully, you can now accept our paper for publication.

Kind regards

Wim de Rooy and co-authors

*- I understand that the main goal was to improve the quality of low cloud forecasts. I would expect that a significant change in clouds would impact near-surface temperatures and moisture, but I did not find a comment about it in the manuscript (only a few comments about the impact on precipitation and winds, in section 4). I suggest that the authors consider adding some comments on that.*

Indeed, near-surface variables are influenced by the model update. We now describe the main (small) overall impact on 2m temperature and humidity as well as 10m wind speed. In general the wind speed itself increases somewhat due to the modifications but (amplitude of) the diurnal cycle is comparable. Small improvements as well as small deteriorations in the near surface output variables can be found depending on the choice of the month or domain. Therefore, we think that adding near surface verification plots would require quite some additional explanation and would distract from the main subject and impact. We now also mention that near-surface parameters are strongly influenced by surface processes (not involved in this study) and representation mismatch between grid box and observation site conditions.

*- Section 2.1, line 119: described -> described*

Done

*- Section 2.2, line 133: epsilon\_k : I suggest that you use the same symbol/Greek letter used in eq. 6*

Done

- *Section 2.2, eq. 7: Should it be overline(theta\_v) in the denominator?*

You are right! Done.

- *Section 2.2, line 137: "updrafts are initialised at the lowest model level" ... does this imply a unrealistic dependence on vertical resolution?*

It seems plausible that a lower resolution, that is a higher first model level, results in a larger excess value of the updraft (compared to the environment). This because of the decrease of grid box temperature and humidity values with height. However, due to the  $z^{-1}$  dependence of the entrainment formulation the excess values decreases with a similar amount as the background. This is explained in detail in Appendix A of Siebesma et al. JAS, 2007 (A Combined Eddy-Diffusivity Mass-Flux Approach for the Convective Boundary Layer). As a result the initialization is rather independent on vertical resolution. This is now mentioned in the text.

- *Section 2.2, line 139: "variance estimated from the surface fluxes"... are you referring to turbulent fluxes? Please clarify.*

We now mention **turbulent** surface fluxes following the standard surface layer scaling of Wyngaard et al. 1971.

- *Section 2.2.1, line 191: "very rapidly" .... how rapidly? Please clarify.*

After the test parcel the number of iterations with the refined entrainment formulations is set to 2 because more iterations have no impact. This is now mentioned in the text. Also a flow diagram is added (suggested by reviewer 2) to clarify the role of the different updrafts and iteration procedure.

- *Section 2.2.1, eq. 9: Please state the z-range of validity (e.g. is it valid for  $z \leq z_{i,dry}$ , then zero elsewhere?)*

Done. We now also mention that  $z_{i,dry}$  is the height where the dry updraft stops rising to explain that there is no need for a dry updraft entrainment above this height

- *Section 2.3, line 305: lineair -> linear*

Done

- *Section 2.4, eq. 32: Should it be  $I_h$  instead of  $I_{\{m,h\}}$ ? Since this equation refers to theta\_I (not momentum)?*

You are right! Changed to  $I_h$

- *Section 3.1, line 474: I suggest to replace "cherry picking" by a less informal expression.*

Done. We now use: to avoid a possible focus on the best results

- *Fig. 12: Please explain the black dots.*

Good point. We now mention in the caption that these dots are the mean of the modelled dimensionless gradients

- *Fig. 19: If possible, I suggest that a vertical scale be added to the vertical axis of the figures in the 3 rd and 4th row (the vertical cross sections).*

Done. This indeed helps to understand the plot more easily.

- *Line 653: I'm not sure I understand "blocky pattern", so I suggest a clarification, or instead a less informal expression*

Replaced by noisy.