

**Manuscript number:** gmd-2021-184

**Title:** Model development in practice: A comprehensive update to the boundary layer schemes in HARMONIE-AROME cycle 40

**By:** de Rooy and Coauthors

### **General comments and recommendations**

The authors provide a detailed description of a set of updates implemented simultaneously in three parametrizations – boundary layer turbulence, shallow convection and cloud schemes – in the HARMONIE-AROME model. The main goal of those updates was to improve the representation of low clouds in that model, which is indeed a challenge faced by many modellers.

I think that the manuscript is well-written, the description of the parametrizations is sufficiently clear, the methods employed to evaluate the impact of model changes are appropriate, the choice of figures and tables is adequate, and the additional material in the appendices is useful. I also think that the contents of the manuscript are of particular interest to the modelling community.

Therefore I believe that the manuscript could be published, once the minor points below are addressed.

### **Minor points**

- 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.
- Section 2.1, line 119: described -> described
- Section 2.2, line 133:  $\epsilon_k$  : I suggest that you use the same symbol/Greek letter used in eq. 6
- Section 2.2, eq. 7: Should it be  $\overline{(\theta_v)}$  in the denominator?
- Section 2.2, line 137: “updrafts are initialised at the lowest model level” ... does this imply a unrealistic dependence on vertical resolution?
- Section 2.2, line 139: “variance estimated from the surface fluxes”... are you referring to turbulent fluxes? Please clarify.
- Section 2.2.1, line 191: “very rapidly” .... how rapidly? Please clarify.
- 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?)
- Section 2.3, line 305: linear -> linear
- Section 2.4, eq. 32: Should it be  $l_h$  instead of  $l_{\{m,h\}}$ ? Since this equation refers to  $\theta_l$  (not momentum)?

- Section 3.1, line 474: I suggest to replace “cherry picking” by a less informal expression.
- Fig. 12: Please explain the black dots.
- Fig. 19: If possible, I suggest that a vertical scale be added to the vertical axis of the figures in the 3<sup>rd</sup> and 4<sup>th</sup> row (the vertical cross sections).
- Line 653: I’m not sure I understand “blocky pattern”, so I suggest a clarification, or instead a less informal expression.