We would like to thank RC1 and RC2 for their thorough reading of our manuscript and for the valuable feedback they provided.

We address all comments in detail below; the corrections made are shown in blue.

Review of “An update of shallow cloud parameterization in the AROME NWP model” by Marcel et al.

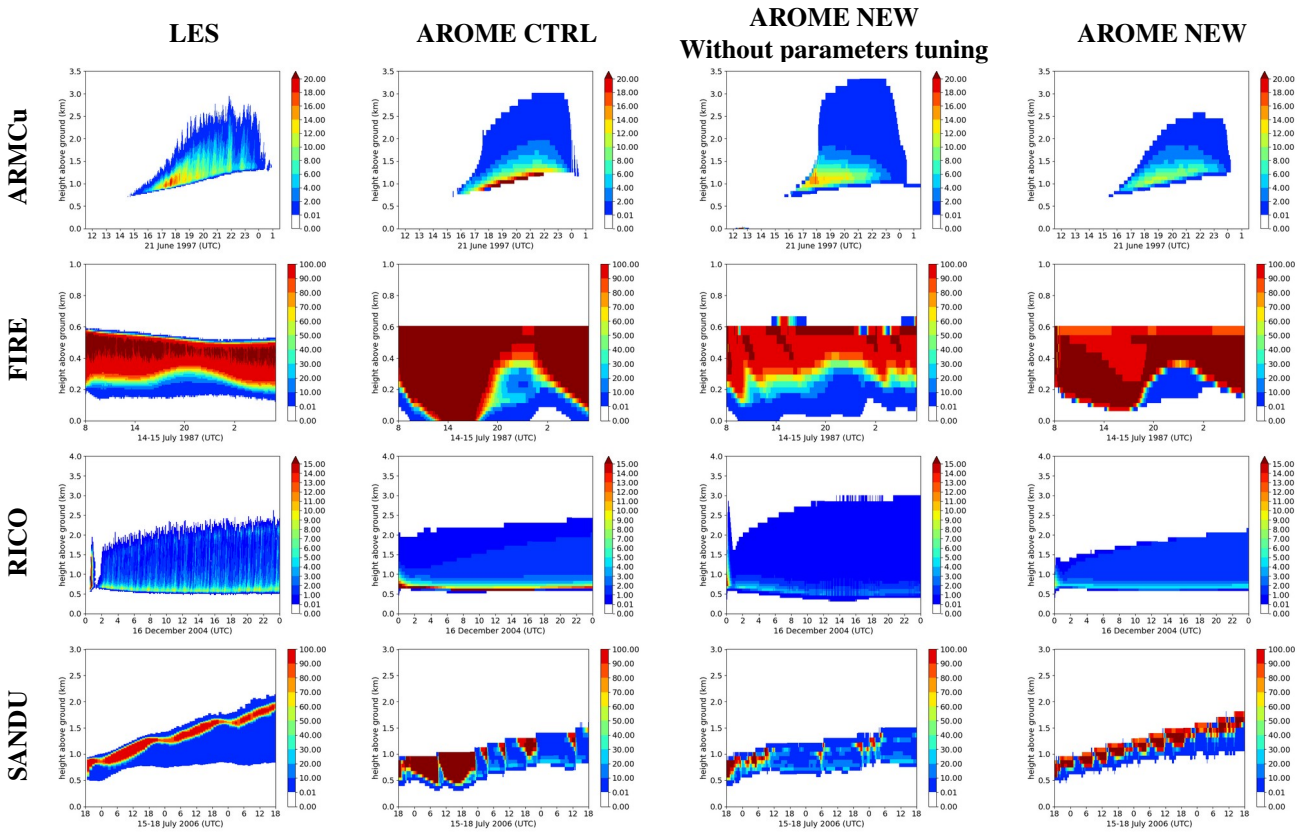
Summary:
This study updated several moist physical parameterization schemes within the AROME NWP model to improve shallow cloud simulation. The work includes evaluations using both Single Column Model (SCM) simulations and Large Eddy Simulationx (LES) simulations across four distinct cloud cases. It also incorporated a semi-automatic parameter tuning tool to enhance model performance. The updated model shows promising improvements in several key variables, such as cloud fraction, cloud and rain water content, and turbulent kinetic energy. The manuscript presents a thorough account of the modifications and their impacts. To strengthen the paper’s scientific contribution and better align it with the scope of ACP, I recommend restructuring the narrative to more clearly highlight the scientific questions and the novelty of the approach. For instance, the paper could focus on one or two key modifications and deeply explore the underlying physical processes.

Major comments:
The manuscript documents a significant number of modifications across several physical schemes. However, it is challenging for the reader to quantitatively assess the specific contribution of each individual modification to the final simulated improvements. The final evaluation of the new AROME configuration includes the cumulative effect of all physical scheme updates plus the parameter tuning from the HTexplo tool. To help the community better understand the physical mechanisms driving the improvements, I strongly suggest a more detailed breakdown.

Specifically, it would be extremely valuable to see a 'Tuning vs. Physics' analysis. This could be achieved by showing a comparison between the control run, a run with all the physical scheme modifications but without the HTexplo tuning, and the final new configuration. This would clearly separate the contributions of the new physics from the new tuning.
Additionally, to further enhance the paper's scientific impact, consider adding a section or a supplementary figure that systematically shows the impact of one or two of the key modifications on the relevant cloud variables. For example, a "Figure 10-13"-style plot that shows the incremental changes from the control run as each major modification is added would be highly informative. This would make the scientific significance of each update much more apparent and provide a clearer path for other researchers looking to adopt similar techniques.

We are aware that the figures presented in Section 3 only provide a general overview of the modifications made for specific cases and model variables. The main problem we face is that showing each change at once does not always result in an improvement in trends (potential temperature, humidity, TKE) and cloud representation (cloud fraction, liquid water content, precipitation) in the model for all 1D ABL cases without a parameter calibration. In addition, some modifications introduce different closures compared to the CTRL version. This makes it more difficult to compare certain parameters before and after the modifications are added. The following figure illustrates the ‘AROME NEW’ experiment with and without parameter calibration. It shows that the uncalibrated version with the modifications is less satisfactory than the CTRL version (for the cloud fraction here).

Without parameter calibration, the successive addition of modifications would lead to a gradual deterioration in the representation of the ABL cases. Therefore, the ideal solution would be to (re)calibrate the entire physics after each modification is implemented to ensure that the set of parameters is plausible in relation to the LES reference. Furthermore, the version of Htexplo is not sufficiently optimized from a numerical point of view. For example, the ten waves used in this manuscript required several days of calculations on a dozen CPUs. Finally, we are also concerned about the constraints in terms of the number of figures.



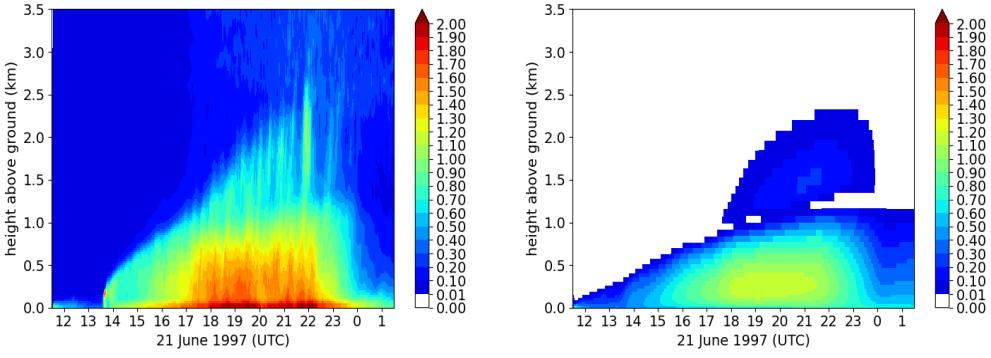
Other comments:

- Line 5: “the associated precipitation” could be rephrased as “the cloud microphysical scheme” for greater specificity. **√ We have corrected the sentence.**
- Line 10: “a transition case” could be more clearly described as “a stratocumulus-to-cumulus case.” **√ Corrected.**
- Line 25: It appears “in” is missing before “Wyngaard (2004)” **√ Corrected.**
- Line 30: To provide a broader context, consider including citations for other HOC schemes, such as the CLUBB scheme used in CESM2 and E3SM models. **√ As the reviewer suggested, we have modified the sentence to include the general CLUBB parameterization.**
- Line 55: The final sentence in this paragraph appears to shift topics abruptly. To improve the flow, please ensure the discussion of radiation and microphysics is more smoothly integrated or moved to a more suitable section. **√ We have revised this part of the introduction.**
- Line 60: between Couvreux et al. (2021) and Hourdin et al. (2021): replace semicolon by comma. **√ Corrected**

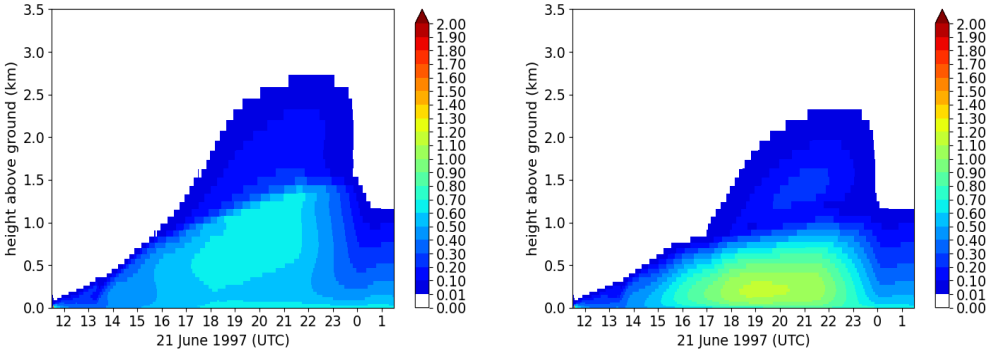
- Line 110: It would be helpful to briefly explain what input profiles and large-scale forcings are used and how they are generated.
- Consider adding a table to summarize the four cloud cases, including their cloud type and time period, for easier reference.

- Section 2.2: To clarify the methodology, please explain the difference between the AROME and Meso-NH models as they are used in the study. Additionally, please specify the horizontal and vertical resolutions used for the Meso-NH LES simulations. **√ In order to respond to the reviewer's advice to clarify the methodology, we have addressed the three previous comments by completing and reworking sections 2.1 and 2.2. In addition, we have added a table in Appendix A, which provides a general description of the ABL cases used, their initial profiles and large-scale forcings, as well as the LES configurations used.**

- Line 170: "where B_u is strong and detrain…": please change "detrain" to "detrains". **√**
- Line 205: in the formula for \bar{s'_{ED}^2}, I believe it should be "\bar{d}^2 * \bar{T'}^2. For clarity, it would also be helpful to show the formulas for CF and \bar{r_c}. **√ The square and the formulations of CF and r_c from CB02 scheme have been added.**
- Figure 2: The LES line shows discontinuous characteristics. A note explaining the cause of this, such as the conditional sampling method, would be helpful to readers. **√ We have added a sentence to section 3.2.2 that specifies this behaviour using the conditional sampling method.**
- Line 305: "fractionnal" → "fractional" **√ Corrected**
- Line 325: It would be helpful to define the parameters alpha and beta directly within the text rather than solely referring to previous studies. **√ We have added the definitions of Alpha and Beta in the section 3.2.3.**
- Line 330: Using 'w' for both "updraft" and "wet" can be confusing. Consider using a different variable, like 'wet' or 'cld,' to distinguish them. **√ We have replace the subscript 'w' by 'm' for the 'moist' part.**
- Figure 5: Consider directly plotting the TKE to more clearly show the improvement between Equation 24 and Equation 22. **√ As suggested by the reviewer, the temporal evolution of the TKE (similarly to manuscript figure 5) is illustrated with the following figure.**
  As we previously explained with regard to parameters calibration, adding a modification without re-calibrating the model's physics can lead to a deterioration in prognostic trends for the wrong reasons. Figure 5 of the manuscript clearly shows an improvement in the transport term using equation 23 rather than equation 25, contrary to the figure showing the temporal evolution of TKE below. This deterioration is linked to error compensation, probably due to an excessively high dissipation coefficient. In this case, we therefore prefer to keep figure 5 of the manuscript.



(a) LES (b) CTRL



(c) CTRL + Eq. (23) (d) CTRL + Eq. (25)

- Line 455: The definition of Max(CF) is unclear. Please provide a clear definition. **√ The definition has been made clearer.**
- Figure 8's caption: "HTexplo experience" → "HTexplot experiment"? The same applies to Table 1's caption. **√ We have replaced all the "experience" by "experiment".**
- Figure 9: The "Remaining space" in the bottom right of the figure could be explained in the figure caption to improve clarity. **√ We have added an additional sentence in the figure caption.**
- L625: While the model shows improvements, the claim that it "can accurately reproduce" cloud fractions and cloud water content might be overstated. Figure 13, for example, highlights several areas where discrepancies remain. To maintain scientific precision, I suggest revising this sentence to acknowledge both the successes and the remaining limitations. **√ We have softened the force of the word used in the conclusion (accurately → better)**