Review of "Optimisation of ICON-CLM for the EURO-CORDEX domain: developments, sensitivities, tuning" by Geyer et al. (2026)

General evaluation:

This study systematically investigated the parameter sensitivity in the ICON model and applied a structured optimization strategy to determine the optimal configuration for ICON-CLM over the EURO-CORDEX domain. The authors present the results from both the expert tuning and the Linear Meta-Model optimisation (LiMMo) method, and the LiMMo method effectively reduces model biases. Specifically, when compared to the default ICON NWP setup, the optimized configuration significantly mitigates underestimated surface air temperature, overestimated incoming shortwave radiation and overestimated latent heat flux over the sea. Based on these improvements, the authors propose this setup as the standard ICON-CLM model configuration for the EURO-CORDEX domain.

The paper provides a clear description of the tuning strategy and its primary findings. I recommend this paper for publication in GMD after the authors address the following comments, which are primarily aimed at providing further clarification.

Major comments:

1. Enhancing clarity (ScoPi and AMSESS)
To ensure the manuscript is a stand-alone piece, additional technical detail regarding the ScoPi and AMSESS metrics is needed, particularly as the primary reference (Geyer, submitted) is currently inaccessible to readers.
- Please include the core equations for ScoPi (e.g., the equation cited in L429) and AMSESS (L406). Providing these within the Methods section will significantly improve the paper's readability and allow readers to evaluate the results without external searching.
- In Table 2 and L440, the text mentions that “different weights are considered per variable.” Please explicitly define how these ScoPi-weights are determined for each variable to ensure the methodology is reproducible.
- To assist the reader in interpreting the results, please clarify the physical or statistical significance of the ScoPi magnitude. Does a higher value represent superior model performance? I suggest briefly introducing this interpretation in the Method section and include a reminder in the relevant figure captions (e.g., “Higher ScoPi values indicate...”) to guide the reader through the results.

2. Implementation of allow_overcast (L231)
The technical implementation of the `allow_overcast` parameter is currently unclear. Specifically:
- On what timescale is this parameter modified (e.g., monthly)?
- How are the user-defined deviations from the mean `aoac` estimated?
- Is `aoa` also a tunable parameter?
- Please elaborate on the physical or modeling rationale for introducing a monthly dependency for this specific parameter.

3. Criteria for Parameter Sensitivity (L500)
There appears to be a discrepancy between the text and Figure 2 regarding "non-sensitive" parameters. For instance, `ecrad_llw_cloud_scatt` (1.8 on psl in JJA) and `czbot_w_so` (1.9/2.0 on tas/tasmax in JJA) show metrics significantly higher than 1.0. Please define the specific threshold or criteria used to categorize parameters as "sensitive" vs. "non-sensitive" to ensure consistency with the visualized data.

Minor comments:

1. Accessibility of Model Configurations

While Table C1 provides a comprehensive summary, the frequency with which configurations like C2I200c, C2I250c, C2I268c, C2I291c and C2I294c are discussed makes it difficult for the reader to track their differences throughout the paper. I would suggest including a condensed table in the main text summarizing these key configurations to provide a quick reference for the reader during the discussion.

2. Parameter descriptions (L193-201)
The tuning parameters require slightly more context in the main body to be fully understood:
- Please clarify that `rat_lam` applies specifically to latent heat flux over land.
- Provide a brief definition or functional description for `cr_bsmin`.
- Ensure an explicit cross-reference to Appendix A is included in this section.

3. Physical drivers of radiation changes (Figure 7 & L559)
The paper notes an increase in downwelling longwave radiation in Figure 7. Please add a brief discussion on the underlying cause. For example, is this change mainly driven by shifts in cloud cover, or are other factors involved?

4. Visualization of parameter impact (Figure 15)
To improve clarity, I suggest labeling the y-axis with the “parameter names” rather than the “Simulation IDs”. Since the discussion centers on the physical impact of specific parameters, this change would make the figure much more intuitive.

5. Consistency in comparison (Figure 21 and 22)
In Figure 21, the authors use `C2I250C` for comparison, but switch to `C2I268C` in Figure 22. Is there a specific reason for switching the reference configuration between these two figures? Please clarify this choice in the text to ensure the comparative logic is transparent.

Technical corrections:

L4: “RCM” appears for the first time without a definition. Please provide the full name here.
L14: Suggest changing “the new configuration” to “the optimization configuration” and “revised external datasets” to “updated higher quality external datasets” for clarity.
L60 & L68: World Climate Research Programme (WCRP) is defined at L60. Please use the acronym “WCRP” directly at L68.
L90 & L213: Correct “parametrisations” and “parametrised” to “parameterisations” and “parameterised.” Please ensure this spelling is consistent throughout the entire manuscript.
L105: Please provide the full name for RMS (Root Mean Square?) at its first appearance.
L110: Change “grows” to “grow.”
L136: Correct “hon-hydrostatic” to “non-hydrostatic.”
L145 & L174: Change “icon” to “ICON.”
L308: Please clarify the intended meaning of “climatology of ECMWF.”
Eq.3: Please define “m.”
Eq.8: Please define “\delta_pm”.
L369: Could the authors clarify the rationale for interpolating observational data to the model grid? If the observations are coarser than the model resolution, please justify this approach.
Table 5: Suggest rephrasing “The signal column defines the parameter signal” into “... denotes the two simulation IDs (without 'C2I' prefix) that are used to estimate the impact of parameter changes.”
Figure 4: Ensure “HWSD v2.0” matches the naming convention used in the Figure 3 caption. Additionally, please explain the notation “C2I232 - C2I230” in the caption for clarity; this suggestion applies to all similar figures.
L543: Based on Figure 6, “do not significantly affect” appears to be a more accurate statement regarding the changes in subgrid slopes.
L585: missing comma between 'itype_z0=2' and 'z0.'
Figure 9: There appears to be a discrepancy in the spatial coverage; the upper panel shows signals over the sea, but the lower panel includes signals over land. Please verify if this is intentional.

Figure 9 (caption): The term "minimum resistance" is used here but does not appear in the Appendix table. Please ensure the terminology in captions matches the parameter tables and main text exactly.
Figure 10: The colorbar title “rsdu” should likely be updated to “rsus.”
L676: Please clarify if “inwp_cldcov” is the same as “inwp_cldcover” and use consistent terminology.
L678: Missing space between “2.6)” and “on”.
L683: Clarify “bottom height” as “cloud bottom height.”
L715: Please check if “reference: -0.05” should be “0.05.”
L717: Please clarify the physical meaning of the phrase “for rh close to 100%.”
Figure 15 & 19: There is mixed use of ScoPi and ScorePEvi in the captions and axis labels. Please standardize these.
L752: Change “since not” to “since it does not”.
L762: Change “on in the second row” to “in the second row”.
Figure 18: The label “swd” in the third column should be changed into “rsds” for consistency with the rest of the text.
L853: “Under consideration for consistency” - please clarify what these are meant to be consistent with.
L938: Change “is resulting in” to the more direct “results in.”
L942: Missing space between “tas,” and “tasmin.”
L999-1000: This sentence (“The ICON-CLM simulations with ...”) is currently unclear; please rephrase it to better convey the intended meaning.