

***Interactive comment on* “The impact of RCM formulation and resolution on simulated precipitation in Africa” by Minchao Wu et al.**

Anonymous Referee #1

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Title: The impact of RCM formulation and resolution on simulated precipitation in Africa

Author(s): Minchao Wu et al.

Recommendation: Accepted with major revisions

General Comments: This paper investigates the impacts of the model formulation and resolution on the ability of two Swedish RCMs to simulate precipitation in Africa. The two RCMs were used at 200, 100, 50 and 25 km resolutions and one of them has two different formulations. This experimental setup allows disentangling the improvements

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related to either the resolution or the model formulation. The topic is of interest and relevant for the RCM community and deserve to be considered for publication. However, I am not sure that the journal Earth System Dynamics is the best journal to convey this study since I very rarely read RCM papers from that journal. I let the editor to decide whether the topic of this paper is suitable for this journal or not.

The paper is very well written and the literature review is very good although the introduction could include more papers related to the topic. Few papers suggested below could be added in the literature review of the introduction. The abstract is generally fine, but few sentences are not clear and should be improved. The introduction is generally clear and interesting, but it should be improved to emphasize the full motivation of the analysis. The methodology is appropriate to address the objectives of the study, but I am concern about the relevancy to run an RCM at 200 and 100 km and the utility of those simulations in the paper. The results are interesting and address the objectives raised at the beginning of the paper. The figures are clear and support the analysis. The conclusions are in line with the analysis and are of interest for the community. Thus, I recommend this paper to be accepted with major revisions.

Major Comments: 1. Introduction: The introduction is interesting and fully explain the motivation of the study. However, it is a bit short and it lacks a more complete literature review of the challenges to simulate precipitation over Africa. Thus, I recommend to extend the paragraph from the line 98 to 117 in 2 or 3 paragraphs to include more RCM studies that paid attention to the challenges to simulate precipitation in Africa with RCMs.

Here is a short list giving examples of papers that could be added to the literature review in the introduction: Evaluation of present-day rainfall simulations over West Africa in CORDEX regional climate models, by Akinsanola, A.A and Ogunjobi, K.O.

Spatial distribution of precipitation annual cycles over South Africa in 10 CORDEX regional climate model present-day simulations, by Favre, A.et al.

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Assessing the Capabilities of Three Regional Climate Models over CORDEX Africa in Simulating West African Summer Monsoon Precipitation, by Akinsanola, A.A. et al.

Simulation of the West African monsoon onset using the HadGEM3-RA regional climate model, by Diallo, I. et al.

Improving the simulation of the West African monsoon using the MIT regional climate model, by Im, E.-S., Gianotti, R.L., Eltahir, E.A.B.

Assessment of the performance of CORDEX regional climate models in simulating East African rainfall, by Endris, H.S. et al.

Downscaling reanalysis over continental Africa with a regional model: NCEP versus ERA Interim forcing, by Druyan, L.M, Fulakeza, M.

Climate simulation over CORDEX Africa domain using the fifth-generation Canadian Regional Climate Model (CRCM5), by Hernández-Díaz, L. et al.

Evaluation of rainfall simulations over Uganda in CORDEX regional climate models, by Kisembe, J. et al.

The diurnal cycle of precipitation in regional spectral model simulations over West Africa: Sensitivities to resolution and cumulus schemes, by He, X. et al.

2. Methodology: Even with the warnings at lines 183-184 and 488-490, I really wonder if it is relevant to use an RCM at 200 and 100 km resolutions and I also wonder if the use of those simulations adds substantial information to the paper. I think that 200 and 100 km are excessively far from the RCM range of resolution or comfort zone for which it is configured and calibrated and I think that little is gained from those simulations in this paper. Thus, either the authors should be really convincing that those resolutions are relevant and add substantial content to the paper or either they should remove at least the 200 km resolution simulations from the paper. In some sense, the 100-km resolution simulations may be relevant since they are at a resolution close to ERA-Interim and can be used as a “no added-value experiment”. Additionally, by removing

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the 200 km resolution simulation, only an aggregation to 100 km would be necessary for the analysis, leading to more details of the simulated precipitation in the results section.

3. Due to the large African domain and that no spectral nudging was used, I am wondering if the internal variability as mentioned in the line 175 would be large enough to produce large differences between simulations from the same model ? Thus, I would suggest the authors to rerun the 50-km resolution simulation of one of the two RCMs with different initial conditions or different starting time and repeat the analysis to see if the IV could affect the simulated precipitation.

4. Conclusion: The discussion of the results in the conclusion is a bit thin and the opening towards additional studies that could follow that one is missing. I would suggest the authors to add some discussions about the results and provide few ideas towards additional studies that could follow that one.

Minor Comments: 1. Title: I think that abbreviations should not be used in titles in general. Thus, I suggest to replace “RCM” by “regional climate model” in the title. 2. Lines 25 and 183: Please add a “-“ after ALADIN or use parentheses to name the two models. 3. Line 27-29 and 42-43: Something is wrong with these sentences. Please correct them. 4. Line 32-34 and 35-39: The sentences are not clear and some points are repeated. Please improve all the sentences of those lines and simplify the message conveyed. 5. Lines 66, 72, 88, 94, 97, 122, 173 etc: The word “results” is used too many times, is too vague and sometimes inappropriate. Sometimes it means the outcome of downscaling. In another context, it refers to the outcome of the analysis. I would suggest to use other words to avoid confusion. As instance, the word “simulation” could be used at lines 66, 72, 173. Please pay attention to every time the word “results” is used and consider using another word or changing the sentence to be more specific. 6. Line 92 and 464. Torma et al. 2015 a and b are the same paper. In addition, I believe that the paper of Giorgi et al. (2016) is more appropriate giving the context. Giorgi, F., Torma, C., Coppola, E., Ban, N.,

Schar, C., and Somot, S.: Enhanced summer convective rainfall at Alpine high elevations in response to climate warming, *Nat. Geosci.*, 9, 584–589, 2016. 7. Lines 113 and 143: Remove “e.g.” 8. Line 146 and the rest of the paper: About the use of RCA4-v1 and RCA4-v4 to distinguish the two RCA model formulations. I think that v4 is not the best way to name the reduced turbulent mixing simulation since 4 brings in mind that v2 and v3 are existing and that they are not used in this paper. I would suggest to use RCA4 and RCA4-RTB for Reduced Turbulent Mixing to name the two RCA simulations. 9. Lines 171-178: I am confuse here about the size of the domains at different resolutions. Is the size of the free domain or full domain including the nudging zone the same between the simulations? Moreover, at line 175, it is mentioned that an additional experiment at 0.88° was performed, but this experiment is never mentioned later on in the analysis. Maybe the sentence of the line 176-178 refer to the two 0.88° simulations. Please pay attention to all the sentences of those lines and specify clearly, which simulation are referred. 10. Line 180-181: For these simulations Please specify which simulations? 11. Table 1. What the small “a” after 222x222 means? 12. Line 203: Please specify the time period covered by TRMM and be more specific on the time period used for the analysis of Figures 5-6. I think that TRMM starts in 1997 or 1998. Moreover, considering the little amount of weather stations in Africa that are used to create CRU, UDEL and GPCC, I think that TRMM figures covering a subset of the full 1981-2010 could be used in Figures 2, 3 and 4 as it is done in Nikulin et al. (2012). 13. Line 229: Replace “most northern” by “northernmost”. 14. Lines 237-239: Please improve the sentence that is not clear. 15. Figure 2 and 3: Color scale on the left: The values above 15 mm/day could be removed as in Nikulin et al. (2012) 16. Figure 2 and 3: Color scale at the bottom: I would suggest to use a white color between -0.5 and 0.5. This would prevent the color change at 0 that is misleading. As example, the Sahara desert is sometimes yellow or blue because there is almost no precipitation falling there. 17. Figure 2 caption: Please emphasize that the values are aggregated at 200 km. 18. Line 284-286: Please give more details about the statement here. 19. Lines 333-335: Please clarify what is meant by “completely opposite behavior”. 20.

Lines 458-460: It is not clear to me that the 50 km HCLIM simulation shows higher frequency than the 25 km HCLIM simulation. 21. Figure 6: Please emphasize in the caption that the season is different for the different regions. 22. Lines 540-541: There are mistakes about the Figure numbers. 23. Reference: Please remove the capital letters of the title of Sylla et al. (2013).

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