Reply to the comments of editor for the manuscript hess-2020-113.

Comments from the Editor:

Thank you for providing your response to reviewers' comments. Please go ahead and submit the revised manuscript along with responses to the comments. In your response please also include page #, line # to specify where in the manuscript the changes are made in response to a given comment. Thank you and I look forward to seeing the revised manuscript.

Reply to the comment of the Editor:

Thank you very much for your comments. Please find below, answers to reviewers' comments and changes including the page number and lines to specify where in the revised version the changes are made.

Reply to the comments of the referee 1 for the manuscript hess-2020-113

Major/Specific Comments:

1. **Comments:** As noted above, my main concern stems from your year choices. While this results in 6 experiments for comparison, I am not convinced that the results are robust given only a 2 year sample size. Moreover, I'm curious how these years were chosen -are they extreme wet and dry years? How often do years such as these occur? How is "wet" and "dry" defined?

Author's response:

Thank you for your comment. For this revised version, as recommended, we re-run the simulations over 5 years (2001 to 2005) during the months of June to September over our West African domain. We superimposed the 5 years and their average in order to analyze the influence of initial soil moisture condition (Fig1 below, added in the revision version of Part 1). The Fig.1 (from Part 1 article) shows that the weakest and strongest impact of the dry experiments is found for 2003 and 2004 respectively. For a wet year, the impact of drying out soil moisture is quickly erased. While for a dry year the impact of the drying of the soil is accentuated. This means that 2003 and 2004 are respectively the wettest and driest years in dry experiment. However, for the wet experiments, the weakest impact is found for 2004, and the strongest impact is found for the years 2001, 2002 and 2004. In a dry year, the impact of soil humidification is very quickly erased, while in a wet year the impact of soil humidification is accentuated. The wet experiments confirm the result *obtained in dry experiments, 2003 and 2004 are wettest and driest years respectively. To estimate the limits of the impact of internal soil moisture forcing on the new dynamical core non-hydrostatic of RegCM4, we have used the two extreme years 2003 and 2004 (resp. the wettest and the driest years) among the 5 years. It is in the same context, several previous studies chosen two extreme years for their sensitivity study of initial soil moisture condition on the models. Hong and al. (2000) used in their study only two years (3 months per year) to investigate the impact of initial soil moisture over the North of America (in the Great Plains) during the two summers, May-June-July (MJJ) 1988 (corresponding to a drought in the Great plains) and MJJ 1993 (correspond to a flooding event). Over Asia, Kim and Hong (2006) in their paper "Impact of Soil Moisture Anomalies on Summer Rainfall over East Asia: A Regional Climate Model Study" used two contrasted years 1997 (below normal precipitation year) and 1998 (above normal precipitation year).*

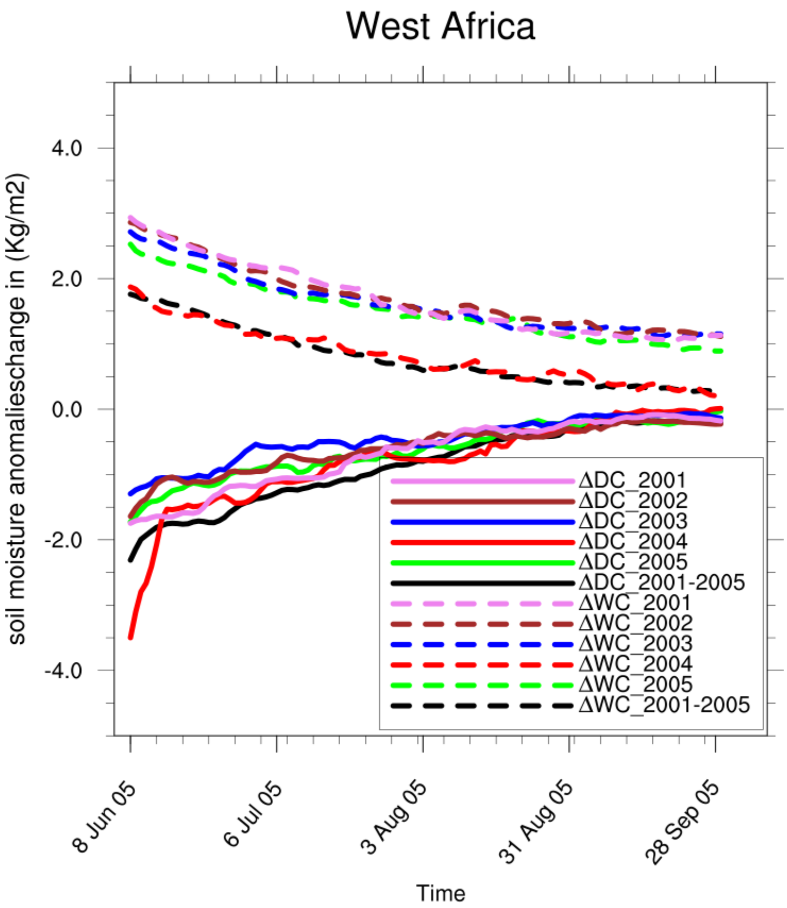

Fig.1: Changes in daily soil moisture for 5 years (2001 to 2005) and their climatological mean during JJAS over West African domain, from dry (ΔDC) and wet (ΔWC) experiments with respect to their corresponding control experiment.

***Author's changes in manuscript**: We did this following modification in the manuscript at*

Section 2.1 line 107 to 115:

As mentioned in part I, we performed these sensitivity studies to the initial conditions of soil moisture over our West African domain for June-July-August-September (JJAS) from 2001 to 2005 with a focus on two contrasted years 2003 (above normal precipitation year) and 2004 (below normal precipitation year). The two years 2003 and 2004 (resp. the wettest and the driest years among the 5 years) have been selected in the aim to estimate the limits of the impact of internal soil moisture forcing on the new dynamical core non-hydrostatic of RegCM4. Several previous studies used two extreme years for their sensitivity study of initial soil moisture condition on the models (e.g Hong and al., 2000; Kim and Hong,2006).

2. Comments from referee 1:

I'm not sure I understand why you discard the first 7 days as spin-up – perhaps because I'm used to prediction, where those 7 days are included in the forecast and would show large impacts of soil moisture initialization.

Author's response: *Thank you very much. Spin-up is a concern when there is a lack of data or seasonal simulation (Rahman and Lu, 2015). Overestimating the spin-up period would lead to a loss of important information. Likewise, an underestimation will lead to integrate errors in the analysis due to the fact that the model does not reach the dynamical equilibrium between the lateral forcing and the internal physical dynamic of the model. Yes, you're right, Anthes et al. (1989) demonstrated that regional models attain the dynamical equilibrium in 2-3 days spin-up period. However, Kang and al.(2014) by comparing different land surface schemes (BATS and CLM3) and different periods of spin-up to simulate June – July – August precipitations recommended 7 days as spin-up period. In this study, we used CLM4.5 as land surface scheme (Oleson et al., 2013) which has a more complex design. That's why we used 7 days as spin-up period.*

Author's changes in manuscript*: We did this following modification in the manuscript at* ***Section 2.1 line 118 to 123****: Kang and al. (2014) by comparing different land surface schemes (BATS and CLM3) and different periods of spin-up to simulate June – July – August precipitations recommended 7 days as spin-up period. In this study, we used CLM4.5 as land surface scheme (Oleson et al., 2013) which has a more complex design.* The first 7 days (Kang et al., 2014) are excluded in the analysis as a spin-up period.

3. Comments from referee 1: It would be prudent to discuss the implications of this work beyond a summary, perhaps in the concluding remarks.

Author's response*: Thank you for your comment. The section summaries and the discussion in the conclusion section have been improved to show implications of this study.*

Author's changes in manuscript*: We did this following modification in the manuscript: Please see new section summaries and in* ***Section 4 (in the conclusion) lines 666-669 we add****: This study helps to understand the impact of the initial soil moisture conditions on extreme events of precipitation and temperature in terms of intensity and duration over West Africa. It is a contribution to the improvement of extreme events forecasts in West Africa in highlighting the crucial role of initial soil moisture.*

4. Comments from referee 1: You offer a comparison of CHIRPS and TRMM, and find large differences in the two datasets. How does this impact your results?

Author's response: *Thank you for your comment. These differences between the observation datasets have been revealed in several previous works over West Africa. For instance when comparing TRMM, GPCP and FEWS, Sylla et al. (2013) pointed out significant discrepancies between these products, whilst Nikulin et al. (2012) as well as Diallo et al. (2013) found large differences between gauge-based observations and satellite products. We have chosen CHIRPS because of its high resolution and mainly because this product has been widely assessed and compared with other datasets and considered as more appropriate for study of extremes events in West Africa by Bichet et al 2018a, b and Didi et al 2020.*

- Bichet, A., & Diedhiou, A. (2018a). West African Sahel has become wetter during the last 30 years, but dry spells are shorter and more frequent. *Climate Research*, *75*(2), 155-162.
- Bichet, A., & Diedhiou, A. (2018b). Less frequent and more intense rainfall along the coast of the Gulf of Guinea in West and Central Africa (1981 2014). *Climate Research*, *76*(3), 191-201.
- Didi Sacré Regis M , Mouhamed, L., Kouakou, K., Adeline, B., Arona, D., Koffi Claude A, K., ... & Issiaka, S. (2020). Using the CHIRPS Dataset to Investigate Historical Changes in Precipitation Extremes in West Africa. *Climate*, *8*(7), 84.

Author's changes in manuscript*: We did this following modification in the manuscript at*

Section 3.1.2 line 248 to 251: *This shows a quite discrepancy among the observation datasets over West African domain. We have chosen CHIRPS because of its high resolution and mainly because this product has been widely assessed and used for study of extremes events in West Africa by Bichet et al. (2018a, b) and Didi et al. (2020).*

5. **Comments from referee 1**: I have this problem a lot with manuscripts that include extreme indices – there area huge amount of indices to show, and this adds to length and can cause the reader to get lost in the paper as you go through each one. figures is a lot! I like the way that you have isolated each index, but I think you could cut down on the detail slightly to save some words and not have the reader get lost in the details.

Author's response: *Thank you for your comment. We tried in this revised version to ease the reading in removing details where necessary.*

Minor/Technical Comments:

1. Comments from referee 1:

I noticed a number of grammatical and spelling errors in the manuscript, I suggest having someone read and edit the manuscript specifically for editorial remarks such as these.

Author's response: *Thank you for your comment. We did our best to improve the revised manuscript.*

2. **Comments from referee 1:** You use a number of parenthetical references such as "impacts of the wet (dry) soil moisture on wet (dry) years etc." - I do not mind these at all, but sometimes the text is very difficult to read when they are used in excess. For example, line 464-468.

Author's response: *Thank you for your comment. We reduced this style of writing in the revised version to make it easier to read.*

3. Comments from referee 1: Define the lat and lon range of your domain(s).

Author's response: *West Africa simulation domain Grid coordinates: 1: points=20748 (182x114) lon : -20 to 19.82 by 0.22 degrees east lat: 0 to 24.86 by 0.22 degrees_north.*

Author's changes in manuscript: *We did this following modification in the manuscript at*

***Section 2.1 line 96 to 98**: The integration of RegCM4 over the West African domain is shown in Fig. 1 with 18 vertical levels and 25 km (182x114 grid points; from 20∘W-20∘E and 5∘S-21∘N) of horizontal resolution.*

4. Comments from referee 1: Line 102: Does this contradict your statement on line 23 of part 1? Perhaps rewording is necessary.

Author's response: *Thank you for your comment. We rewrote the sentence. Instead of a "season", we specify in this revised version the number of months ("four months").*

***Author's changes in manuscript**: We did this following modification in the manuscript at **Section 2.1 line 106**: The sensitivity of the initial soil moisture does not exceed four months (Hong and Pan., 2000; Kim and Hong, 2006).*

5. Comments from referee 1: Line 138 to 147: I believe you're talking about autocorrelation - neighboring grid points are spatially dependent. You do not necessarily need to resample, but you can estimate your n given autocorrelation - sometimes called effective sample size. I think you're using NCL in much of this manuscript (at least, your Figures look like NCL!), which has functions to calculate sample autocorrelation and equivalent sample size.

Author's response: *Thank you for your comment. We do not seek to resample our data.*

We used the student t test to investigate the statistically significant differences between the control and the wet/dry sensitivity experiments at each grid cell as did by Liu et al (2014) in similar work over Asia. Due to the multiplicity problem of independent tests and the spatial dependency of neighboring grid points, the significant results can only be seen as a crude estimate. To justify this, Jager and Senviratne said that more reliable estimates of significance could be obtained using resampling methods proposed by Wilks (1997) for auto-correlated Fields. However, this is not feasible in our case due to the computational constraints associated with the size of our domain studied.

Author's changes in manuscript: We rewrote it to make it more comprehensive. We did this following modification in the manuscript at **Section 2.1 line 154 to 158**: The statistically significant differences has been tested between the control and the sensitivity experiments, we perform the two-tailed of the student's t-distribution at every grid points as did by Liu et al. (2014) in a similar work over Asia. Due to the multiplicity problem of independent tests and the spatial dependency of neighboring grid points, the significant results can only be seen as a crude estimate.

6. Comments from referee 1: Line 198: "Indicating that the number of wet days occurrence are occurred more likely not only in wet experiments but also in the dry experiments." I do not understand this sentence.

Author's response: *Thank you for your comment. We would like to say that the increase of the number of wet days occurred not only in wet experiments but also in the dry experiments. As suggested above, we removed details to ease the reading.*

Author's changes in manuscript*: We did this following modification in the manuscript at* ***Section 3.1.1 line 211 to 212****: However, over the Guinea coast sub-region, both wet and dry experiments show a significant increase of R1mm, although weaker in the dry experiments.*

7. Comments from referee 1: I noticed that sometimes your section summaries only include some of your results - is there a way to make these more comprehensive without adding to length?

Author's response: *Thank you for your comment. We rewrote these section summaries to make them more comprehensive. Please see section summaries in the revised manuscript.*

Reply to the comments of the referee 2 for the manuscript hess-2020-113

Major/Specific Comments:

1. Comments from reviewer 2:

Model evaluation: The authors need to either demonstrate that the model used can reproduce precipitation or temperature extremes in the study region or provide a citation demonstrating this otherwise this model may not be a good tool for this research question. It's important that the evaluation be of precipitation extremes rather than the means or seasonal cycle (as in Koné et al. 2018) since that is what the authors are focusing on.

Author's response: *Thank you for your comment. The RegCM model is one of the most widely used models by the scientific community to reproduce mean and extreme climate a most anywhere in the world. In this study we evaluated its performance in West Africa for* *extreme climate. The model performs well in West Africa as well as in Asia in the representation of mean and extreme climate. The choice of a complex land surface model CLM4.5 coupled with RegCM4 need to be evaluated since it is not done before in climate extreme study over Africa. As compared with a previous study done by over Asia, RegCM4 reproduce well thee precipitation and temperature extremes over Africa.*

Minor/Technical Comments:

1. ***Comments from reviewer 2***:

Minor points: Statistical significance: Perhaps I misunderstood the methods, but it seems like statistical significance can't be evaluated using this model setup (which is okay) but it shouldn't be presented as if it can. Each point only has a control year and two models run right? Please explain this further, the methods section does not provide enough detail here. What is your null distribution and what is your test distribution at each point?

Author's response*: Thank you for your comment. Our null hypothesis is the sample means are from the same population (i.e.H0: ave1=ave2). We used the student-t distribution. Rejection of the null hypothesis (i.e. acceptance of the alternative hypothesis) indicates that the sample means are from two different populations.*

Author's changes in manuscript*: We did this following modification in the manuscript at* ***Section 2.2 line 154 to156****: The statistically significant differences has been tested between the control and the sensitivity experiments, we perform the two-tailed of the student's t-distribution at every grid points as did by Liu et al. (2014) in a similar work over Asia.*

2. Comments from reviewer 2: PDF figures: In my opinion the PDFs don't add information and should probably be removed from both manuscripts to save space.

The PDFs duplicate the spatial maps of changes, which provide more information, and double the number of figures presented.

Author's response*: Thank you for your comment. The use of PDFs is important because it gives important information such as how many grid points are impacted, what are their highest value of biases and help to quantify the impact of the initial soil moisture conditions. The mean biases can't give such information.*

Author's changes in manuscript*: We did this following modification in the manuscript at* ***Section 2.2 line 149 to 153****: To quantify the impact of soil moisture anomalies on climate extremes Liu et al. (2014) in their work over Asia, used the mean biases in 5 subregions,* *while in our study we used the mean biases and the probability density function (PDF, Gao et al. (2016); Jaeger and Seneviratne (2011)) for this purpose to better capture how many grid points are impacted by initial soil moisture and their highest value.*

2. **Comments from reviewer 2:**

Pattern correlations in Table 3: It's not clear exactly how to interpret the pattern correlations for temperature. A value of 0.99 for every single value seems to imply that either there's an error in the calculation or that the metric is not useful. Are the temperature datasets this closely aligned, and if so would it be more useful to assess pattern correlation of temperature anomalies rather than the absolute temperature

Author's response: *Thank you for your comment. The pattern correlation coefficient is a common statistical tool used in modeling to assess the large-scale correlation between two different products. High value of PCC reveals a good large-scale spatial representation of the pattern of temperature by RegCM model (Diallo and al. 2013; Diallo and al 2016, Koné and al. 2018).*

3. **Comments from reviewer 2**:

I assume that the labels for TRMM should be EIN here as well.

***Author's response**: Thank you for you. We don't know at which line this confusion is done but we improved the quality of the figures in this revised version.*