Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2020-112-AC2, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Influence of initial soil moisture in a Regional Climate Model study over West Africa: Part 1: Impact on the climate mean" *by* Brahima Koné et al.

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Received and published: 4 August 2020

Reply to the comments of the referee 2 for manuscript hess-2020-112

We thank the reviewers for the careful review and positive comments which helped to improve the manuscript. Please find our answers to comments in italic as well as suggested text changes in yellow in the revised version.

1. Comments: How were the years 2003 and 2004 chosen? Perhaps show a time series of precipitation anomalies in your study region to highlight why you chose 2003 and 2004. "Dry" and "wet" are very subjective terms. Or consider showing observed

precipitation and soil moisture anomalies during 2003 and 2004.

Author's response: Thank you for your comment, our choice of year stems from a long-term study of rainfall anomalies carried out over the sensitive Sahel zone from 1950 to 2004 (cf fig. below), which shows precipitation anomalies of about $\pm$ 1.5 mm of rainfall for the consecutive years 2003 (positive anomalies) and 2004 (negative anomalies). The two contrasted years in West Africa (in 2003 wet year and in 2004 dry year compared to the mean 1950-2004 cf fig. below) have been chosen in the aim to assess the results of the sensitivity study, whatever the year studied.

Choice of soil moisture data:

2. Comments: Why initialize soil moisture with ERA 20C, which includes only surface forcings of surface pressure and marine winds only? How well does this dataset compare to satellite-derived observations? ERA 20C isn't really a reanalysis of soil moisture, because the soil moisture doesn't include any observations. If the authors want an observationally-based soil moisture dataset, they could consider a product like GLEAM (Martens et al., 2017; Miralles et al., 2011).

Author's response: Thank you for your comment. The soil moisture initialization data of the RegCM4 climate model consists of three surface soil moisture datasets: ERA20c, ESACCI and CPC. We performed a sensitivity study of RegCM4 to these three different data sets in simulating the mean and extreme climate of West Africa. The sensitivity test showed good performance in quantitative assessment of temperature and rainfall simulations of ERA20C data over the entire domain of West Africa and its sub-regions. This is what justified our choice for ERA20C.

3. Comments: You show the observations for precipitation, perhaps show observations for soil moisture too. You could show ERA20C (which you added) and maybe GLEAM as an independent dataset.

Author's response: Thank you for your comment. The aim of this work is to study the

impact of soil moisture initial conditions in simulation of the climate mean and extreme over West Africa. Due to discrepancies between the datasets in West African region, we used two observational data for temperature and precipitation to validate our simulation outputs. We do not seek in this study to validate soil moisture data.

4. Comments from referee 1: Using global wilting points and ïňĄeld capacity: In the dry and wet runs the authors use a uniform wilting point and ïňĄeld capacity everywhere. But we expect that both the permanent wilting point and the water holding capacity of the soil differ by location (see, for example Figure 6 of Leenaars et al., 2018). These two values will be radically different in the Sahara Desert and southern Nigeria, for example. The assumptions made here, that wilting point is 0 or that ïňĄeld capacity is 0.489 is likely unrealistic for many locations, and these extreme initial conditions may be affecting the results. The authors need to more completely justify the use of these initial conditions, as opposed to using the maximum and minimum observed values, for example.

Author's response: Thank you for your comment. We use the minimum and the maximum soil moisture datasets value in our simulation domain. The two values obtained is defined as volumetric fraction ranging from the permanent wilting point (=0.117*10-4) to the field capacity (=0.47). Previous studies on Asia and North America have been conducted in the same way (Hong and Pan (2000); Kim and Hong (2006)).

Author's changes in manuscript: Please see the manuscript at Section 2.2 Line 151-153

5. Comments: Effect of methods on the analysis: The fact that the wet year (2003) and the dry year (2004) look the same in most graphs when used as the control seems to indicate that they're either quite similar, or that the values for initial soil moisture are incredibly strong, and are overwhelming everything about the dry vs wet year. Are extreme values of soil moisture like this really useful? If so, the authors need to better justify them. I understand that this is a sensitivity analysis, but the authors need to

contextualize how relevant this sensitivity analysis is to the conditions of the real world.

Author's response: Thank you for your comment. We recognize that sensitivity experiments such as "wet" and "dry" ones conducted in this study were not intended to simulate real climate since such extremes are very rare. These kinds of experiments, however, can provide estimates of the limits of the impact of internal forcing such as soil moisture.

Author's changes in manuscript: Please see the manuscript at Section 4 Line 484-487

6. Comments: Starting at a soil moisture of 0 is quite extreme. how, for example the local minimum and maximum soil moisture estimated for the region in the target starting month (June) in an observational dataset as comparison. Showing local min/max for each pixel would demonstrate how the initial conditions used compare to what has historically been experienced.

Author's response: Thank you for your comment. Well, that's what we did with our domain of simulation.

Author's changes in manuscript: Please see the manuscript at Section 2.2 Line 148-150.

References:

Hong S-Y. and Pan H. L.: Impact of soil moisture anomalies on seasonal, summertime circulation over North America in a regional climate model. J. Geophys. Res., 105 (D24), 29 625–29 634, 2000.

Kim J-E., and Hong S-Y.: Impact of Soil Moisture Anomalies on Summer Rainfall over East Asia: A Regional Climate Model Study, Journal of Climate., Vol. 20, 5732–5743, DOI: 10.1175/2006JCLI1358.1, 2006.

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