Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC2
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Comment on gmd-2021-348

Anonymous Referee #2

Referee comment on "The impact of lateral boundary forcing in the CORDEX-Africa ensemble over southern Africa" by Maria Chara Karypidou et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-348-RC2, 2022

This is an interesting paper assessing the impact of the GCM as compared to the RCM on a domain in Southern Africa. However, I think there are some concerns and questions that need to be addressed before the paper is ready for publication.
Variance between the models (RCMs or GCMs) has been employed to compare the model performance for the simulation of the monthly precipitation. In my reading, this study aims to show how much each RCM output is affected by its driving GCM. However, some concerns that may be critical should be addressed if the information provided in this study will eventually be used by both climate and non-climate scientists, as the authors mentioned.

- RCM output can be affected not only by the input GCM datasets but also by its parameterization, configuration, options, and setup. A simple comparison of the variance of monthly data between the complex models does not guarantee whether or not the impact of the driving GCM is dominant. All possible outcomes or limitations should be discussed to show the relationships between the RCMs and GCMs.
- How the relaxation zone has been defined to simulate each RCM should be addressed. Bias can be amplified through the lateral boundary conditions.
- The reasons why the three RCMs have been chosen should be addressed in the data section. If they have shown good performance in the domain, I suggest adding related references.

Specific comments:

l57 - The authors should perhaps also cite the RCM lateral boundary papers focussing on Southern Africa authored by Ditiro Moalafhi, given the focus there is the impact of changes to lateral boundary conditions, with bias assessed based on a reanalysis dataset. These papers are:
1 Moalafhi, D. B., Sharma, A., Evans, J. P., Mehrotra, R. & Rocheta, E. Impact of biasâ□□corrected reanalysisâ□□derived lateral boundary conditions on WRF simulations. Journal of Advances in Modeling Earth Systems (2017).
2 Moalafhi, D. B., Sharma, A. & Evans, J. P. Reconstructing hydro-climatological data using dynamical downscaling of reanalysis products in data-sparse regions–Application to the Limpopo catchment in southern Africa. Journal of Hydrology: Regional Studies 12,

378-395 (2017).
3 Moalafhi, D. B., Evans, J. P. & Sharma, A. Influence of reanalysis datasets on dynamically downscaling the recent past. Climate Dynamics 49, 1239-1255 (2017).
4 Moalafhi, D. B., Evans, J. P. & Sharma, A. Evaluating global reanalysis datasets for provision of boundary conditions in regional climate modelling. Climate Dynamics 47, 2727-2745, doi:10.1007/s00382-016-2994-x (2016).

l89 - I would like to point the authors to papers on correcting lateral and lower boundary variables focussing on Australia, where the focus was the representation of drought, and the RCM used was WRF. While here the authors are using an ensemble of GCMs, these papers focussed more on what the representation of different attributes in the lateral and lower boundaries did to the overall monthly outcomes. These papers are:
1 Rocheta, E., Evans, J. P. & Sharma, A. Correcting lateral boundary biases in regional climate modelling: the effect of the relaxation zone. Climate Dynamics 55, 2511-2521, doi:10.1007/s00382-020-05393-1 (2020).
2 Rocheta, E., Evans, J. P. & Sharma, A. Can bias correction of regional climate model lateral boundary conditions improve low-frequency rainfall variability? Journal of Climate 0, null, doi:10.1175/jcli-d-16-0654.1 (2017).

Of special interest to this study is the first paper that assessed the progressing deterioration in the corrections as one focussed deeper into the domain (away from the relaxation zone). I think the authors have missed this entire volume of work as I see no references to these papers. Please also note the different levels of impact lower versus lateral boundaries end up having on the simulations.

I also urge the authors to read the additional more recent papers:
1 Kim, Y., Evans, J. P., Sharma, A. & Rocheta, E. Spatial, temporal, and multivariate bias in regional climate model simulations. Geophysical Research Letters 48, e2020GL092058 (2021).
2 Kim, Y., Rocheta, E., Evans, J. P. & Sharma, A. Impact of bias correction of regional climate model boundary conditions on the simulation of precipitation extremes. Climate Dynamics 55, 3507-3526, doi:10.1007/s00382-020-05462-5 (2020).

Here the focus was on extremes, which were found to be impacted to a greater extent by the lateral boundary corrections, than th e overall monthly attributes. Please also note the more recent of the two papers that attempted to quantify the impact of multivariate dependence bias in the lateral and lower boundaries, noting that the lack of this plays a significant role in the over quality of simulations.

I must confess that I am an author to the above papers, and leave it to the authors (and editor's) judgement whether my suggestions above are essential to the present study. However, in my reading of the current paper, I did feel the above referenced works do add to the story the authors are trying to tell, as they focus on a similar domain (Moalafhi) and altered lateral boundaries (all).

l172 - please clarify if this is for the mean or the monthly series.

l184 - there seems to be a mistake in the notation here, or also in equation 2. Please check. GCMi should refer to the variance of all RCMs driven by GCMi? Also, what is N?

l187 - similar confuision about the notation as earlier - please check and correct.

Figure 2 and 3 - It would have been nice to also show the observed climatology in this figure.

Remaining figures and ANOVA analysis - I found this quite comprehensive and interesting to read. I realise the authors are already reporting a lot of information here, but I was interested on their comments on the following:
(a) what was the impact on Temperature simulations and how the intra-RCM variances there compared against the precipitation?
(b) there is little focus on variability, although the main advantage a RCM brings is the added variability in both space and time. Could the authors comment on within grid variabilities across the RCMs, and change in variability in time at each grid cell?
(c) Our results showed significant impact on precipitation extremes (from altered lateral and lower boundaries). It would be interesting if the authors could comment on this aspect of the RCM simulations compared to the GCM simulations.