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Interactive comment on "A new region-aware bias correction method for simulated precipitation in the Alpine region" *by* Juan José Gómez-Navarro et al.

Anonymous Referee #2

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Review for Geoscientific Model Development (Manuscript gmd-2017-329)

Title: "A new region-aware bias correction method for simulated precipitation in the Alpine region"

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Discussion paper

1 General comments

This paper presents a bias correction method for regional climate simulations over the Alps at very high resolution. A observational database for the region is used for the validation, and ERAinterim and GCM-CESM forcing fields are used to WRF modelling work. To my opinion, it shows enough aspects to novelty and adequate analysis and understanding of the obtained results. I suggest it to be considered for publication, once the questions and requested item can be properly answered or at least taken into account in some way.

1. Missing references. It is always the case that not all the relevant references are included when a work is presented. Here I find some that I consider that are essential to be included, not only for the introductory aspects, but also for the methods and results description. Let me indicate them to the authors for them to be considered a properly used throughout the text

   (a) Torma, C., Giorgi, F., Coppola, E. (2015). Added value of regional climate modeling over areas characterized by complex terrain-Precipitation over the Alps. Journal of Geophysical Research: Atmospheres, 120(9), 3957-3972. This work should be mentioned because of similar modelling domain and resolutions are used, and for sure some of the figures there could be related to the results shown here.

   (b) Fantini, A., Raffaele, F., Torma, C., Bacer, S., Coppola, E., Giorgi, F., ... & Verdecchia, M. (2016). Assessment of multiple daily precipitation statistics in ERA-Interim driven Med-CORDEX and EURO-CORDEX experiments against high resolution observations. Climate Dynamics, 1-24. Here an ensemble of RCMs is used for the whole Europe, but some specific analysis over the Alps is seen.

(c) Giorgi, F., Torma, C., Coppola, E., Ban, N., Schär, C., & Somot, S. (2016). Enhanced summer convective rainfall at Alpine high elevations in response to climate warming. Nature Geoscience, 9(8), 584. Perhaps this specific work could also be included

Other works propose some clustering methods based on precipitation, or other bias correction procedures for precipitation fields as obtained from regional climate models, although perhaps not only for the alpine region, but that they maybe should be considered to be mentioned on this work:

(a) Casanueva, A., Kotlarski, S., Herrera, S., Fernández, J., Gutiérrez, J. M., Boberg, F., ... & Keuler, K. (2016). Daily precipitation statistics in a EURO-CORDEX RCM ensemble: added value of raw and bias-corrected high-resolution simulations. Climate dynamics, 47(3-4), 719-737.

(b) Dosio, A. (2016). Projections of climate change indices of temperature and precipitation from an ensemble of bias-adjusted high-resolution EURO-CORDEX regional climate models. Journal of Geophysical Research: Atmospheres, 121(10), 5488-5511.

(c) Argüeso, D., Evans, J. P., & Fita, L. (2013). Precipitation bias correction of very high resolution regional climate models. Hydrology and Earth System Sciences, 17(11), 4379.

(d) Argüeso, D., Hidalgo-Muñoz, J. M., Gámiz-Fortis, S. R., Esteban-Parra, M. J., & Castro-Díez, Y. (2012). High-resolution projections of mean and extreme precipitation over Spain using the WRF model (2070–2099 versus 1970–1999). Journal of Geophysical Research: Atmospheres, 117(D12).

(e) Manzanas, R., Lucero, A., Weisheimer, A., & Gutiérrez, J. M. (2018). Can bias correction and statistical downscaling methods improve the skill of seasonal precipitation forecasts?. Climate Dynamics, 50(3-4), 1161-1176.

2. Apart from the pure bibliography missing items, there are some aspects that could be more deeply described by the authors. One of them should be to compare the proposed bias correction method with other similar ones, if there are some, to see more clearly differences and similarities with others already proposed. I am sure the quantile mapping procedures have been used before, if one goes to those references. Therefore, I recommend the ongoing work by Nikulin and others in the frame of EuroCORDEX activities, named BCIP. Take a look at this abstract at EGU2015: Nikulin, G., Bosshard, T., Yang, W., Bärring, L., Wilcke, R., Vrac, M., ... & Fernández, J. (2015, April). Bias Correction Intercomparison Project (BCIP): an introduction and the first results. In EGU General Assembly Conference Abstracts (Vol. 17). In a more general sense, perhaps a mention to this recommendation by CORDEX community could be made. take a look at http://cordex.org/data-access/bias-adjusted-rcm-data/, and from there, to a IPCC work focused on this topic: See Breakout Group 3bis: Bias Correction (pp. 21-23) in IPCC, 2015: Workshop Report of the Intergovernmental Panel on Climate Change Workshop on Regional Climate Projections and their Use in Impacts and Risk Analysis Studies [Stocker, T.F., D. Qin, G.-K. Plattner, and M. Tignor (eds.)]. IPCC Working Group I Technical Support Unit, University of Bern, Bern, Switzerland, pp. 171. (https://www.ipcc.ch/pdf/supporting-material/RPW_WorkshopReport.pdf). I can imagine that authors do not want to go too far on this aspect, but I think that some more comments, to have this work inside the wider context, should be made. Even a mention to some developed software for this kind of analysis could be included, such as Bedia, J., Iturbide, M., Herrera, S., Manzanas, R., & Gutiérrez, J. (2017). downscaleR: an R Package for Bias Correction and Statistical Downscaling. R Package Version 2.0-3.

3. I am not sure if the authors have a comment about the fact that this bias correction method has been applied to a region with a very deep orography, and to precipitation field. Which could be the potential to apply it to other regions with

smoother orography, and/or to other variables?

2 Specific comments

1. It has been indirectly mentioned on the general comments section, but here I want to comment if explicitly: I miss a mention to the EuroCORDEX/MedCORDEX activities, that have used plenty of simulations at high resolutions (0.11) over Europe, and several studies with not a single RCM as here, but an ensemble of them, that have analyzed, also forced with ERAinterim fields, how precipitation is described. I do not mean a full comparison with other RCMs, but at least some mention and comparison with them, to see more clearly if WRF-RCM is similar to the state-of-the-art RCMs modelling alpine precipitation for current climate conditions.

2. And also related to this point, I miss some comparison of your figure 5, for example, with figure 2 of Torma et al., 2015 or Fantini et al., 2016, figure 5, not only for RCMs, but also for observational datasets, I am not sure if they are totally consistent. Or for your figure 6 and 7, and their corresponding figures.

3. I have a concern about the domain of study chosen here. On figure 1, D4 subdomain seems to be the one used for the analysis, but then figures with the political borders of Switzerland seem to be used. This relatively artificial borders could add some non-physical or modelling aspects to the analysis, and specially when obtaining the subregions from the clustering procedure. Which is the opinion of the authors about this aspect?.

4. Another point I would like to hear from the authors is about the very high resolution used for the WRF D4 domain (page 5, line 14): 2km. Which one is the real advantage here of using such resolution compared with the even-very-high

6km one?. It seems that no much mention or usefulness is made by the authors to this resolution, by far much larger than the mentioned 0.11 “high resolution” EuroCORDEX standard values these days. It is also a tricky aspect, since the comparison and bias correction method is made against the roughly 20km observational dataset information, and so some statements are made through the text related to this resolution differences. A more complete study should perhaps include at least some other resolution from the WRF model to a better understanding of the resolution topic?.

5. I understand that the forcing GCM is always an open question, but the usage of just one instead of, at least, a couple of them, does not limit a little bit the representativity of the GCM-forced RCM analysis?

6. The result shown in pages 10-11 that related intermediate seasons with cancellation artifacts sounds reasonable, but perhaps a more specific analysis could be made, with moving seasons, to see if more clear picture of that can be obtained. Because on the other hand, this result could be found non-intuitive, as one can think that precisely those transition seasons are more difficult to be properly captured. Which are the thoughts of the authors about it?.

7. Page 11, line 22. The bias corrected result over the frequency distribution that changes from underestimation to overestimation in winter looks a little bit peculiar. Could this result be a little bit further explained?

3 Technical corrections

1. When describing the experimental design (page 5, line 25) I do not understand those 6-day chunks and 12h spinup periods. I thought that a whole year or even two or more where needed for the soil moisture to be adapted. Could this aspect

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be explained a little bit more? I understand that more details can be found in Gomez-Navarro et al., 2015, but perhaps here it is too little what is said. It is the same about D1-D2-D3-D4 subdomains and nesting aspects.

2. Close to this point, I do not also understand why nudging is applied to ERAinterim forced simulation, but not to the ESM one.

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