Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., author comment AC1
https://doi.org/10.5194/gmd-2021-207-AC1, 2021

Reply on RC1

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Author comment on "Added value of EURO-CORDEX high-resolution downscaling over the Iberian Peninsula revisited – Part 1: Precipitation" by João António Martins Careto et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2021-207-AC1, 2021

General comments to Referee #1

We are very grateful for your kind and positive comments and suggestions. We appreciate all of them. We sincerely think that your revision allowed an overall improvement of the manuscript

RC1: This study presents a comprehensive assessment about the added value of precipitation dynamically downscaled regional climate model (RCM) simulations from EURO-CORDEX initiative. To quantify and spatially characterize RCMs performance compared to the corresponding lower-resolution global scale driving fields, Authors take advantage of a distribution-based metric (DAV) previously introduced and presented in Soares and Cardoso (2018). The evaluation regards all the available ERA-Interim reanalysis and global climate models (GCM) driven RCM simulations corresponding to the Hindcast (1989-2009) and Historical (1971-2005) experiments respectively. All the simulations considered refer to the Iberian Peninsula domain and an observational-based Iberian Gridded Dataset (IGD). The present research involves a relevant research question namely if and eventually at what extent downscaled simulations can improve the large-scale forcing signal. This represents a very important point as RCMs are extensively used by a broad range of end users belonging to climate impacts and climate services communities. The main value of the study is to consider the largest dataset of RCMs available and to consider a simple and straightforward metric identifying RCMs potential added value over the entire statistical distribution.

It follows some general, minor remarks:

RC1: -Please better clarify what are the main differences in DAV configuration and application respect to the originally work authored by Soares and Cardoso 2018. Do they consist on considering a larger evaluation and historical period simulations and diving DAV according to precipitation intensity and frequency distribution?

AC: The main differences between this work and the original Soares and Cardoso (2018) are in the number of simulations for the Hindcast runs, the reference observational

database, and the addition of the analysis of the Historical simulations. Here we used all the available 11^{o} resolution EURO-CORDEX 11^{o} simulations, while Soares and Cardoso (2018) considered only the Hindcast which had in common the 0.44^{o} and 0.11^{o} resolutions. Beyond the differences in the models, for this work we used a different observational dataset. In Soares and Cardoso (2018), the authors have the ECAD station data as reference, which does not properly cover the Iberian Peninsula and here we consider a high-resolution dataset, at 0.1^{o}, the Iberian Gridded Dataset (Herrera et al., 2019), which has a very close resolution to that of the EURO-CORDEX models. This new dataset considers more than 3000 stations for precipitation within the Iberian Peninsula, while the ECAD only has a few stations in Spain and just one for Portugal.

Additionally, the methodology splits precipitation into intensity and frequency, while in Soares and Cardoso (2018) only intensity is scrutinised. Here, a spatial distribution of the added value is also provided, while this analysis is absent from Soares and Cardoso (2018).

In the manuscript we have the following:

Line 92: "The first to quantify the added value of the EURO-CORDEX hindcast runs were Soares and Cardoso (2018), evaluating 5 RCMs for precipitation at both resolutions (50 km and 12 km) considering their probability density functions with the station-based dataset ECAD (Klein Tank et al 2002, Klok & Klein Tank 2009) as observational benchmark. This study reported relevant added value of the RCMs against the driving ERA-Interim reanalysis (Dee et al., 2011). Nonetheless, when comparing both resolutions, the improvements are not as significant, with the exception for extreme precipitation."

Line 230: "The same was reported by Soares and Cardoso (2018) for the Iberia Peninsula, despite the low station density considered, the DAVs reveal smaller values for the extremes and higher for the PDF as a whole."

RC1: -I think that an important point of the article is the to some extent poor RCMs performance in reproducing summer precipitation intensity and especially frequency (when the entire statistical distribution is considered). Since summer season generally presents a weaker forcing large scale signal it is relevant that the higher resolution self-generated signal (from RCMs) frequently leads to detrimental effects. I think that this aspect deserves some more discussion. It is interesting also considering that this happens mainly when RCMs are driven by ERA- Interim. Finally, this aspect can have also potential relevant propagating effect on the summer temperature representation.

AC: We thank the reviewer for pointing out the issue, however the disentangling of the root causes of the lower DAV in summer are out of the scope of the article. Nevertheless, we rewrote the paragraph from lines 195 to 207, to aide the interpretation of the lower added value.

" In fact, summer is the season where models display more difficulty in capturing the precipitation features, since it is the driest season for the entire Iberian Peninsula and precipitation is mostly associated to water recycling through soil moisture atmosphere feedbacks (Rios-Entenza et al., 2014). In addition to the added importance of lower precipitation rates which models overestimate (Boberg et al. 2009; 2010; Soares and Cardoso, 2018), the representation of soil moisture in any model is still very challenging thus the weaker performance of the RCMs is not surprising. In fact, the summer PDF for the precipitation intensity (Fig. S1), in comparison with the other seasons, reveal a higher stronger overestimation for the lowest bins and an underestimation in the tails, thus reducing the downscaling added value. Additionally, ERA-interim assimilates soil moisture

and temperature, near surface temperature and humidity thus constraining the local land-atmosphere feedbacks and improving its added value.”.

It follows some line-specific, minor remarks:

RC1: Line 88. It is not clear the meaning of the “namely for temperature”.

AC: We thank the reviewer for pointing out the issue and thus decided to remove this part

RC1: Line 147. Is the normalization performed for both intensity and frequency distributions?

AC: Yes, so that the sum of each individual PDF is equal to 1.

RC1: Please be better specify what you mean with the statement: “sum of the all bins”.

AC: In order to build an empirical Probability Density Function (PDF) from the data we have to bin the data since a theoretical PDF is not considered. However, and particularly for the precipitation intensity, the PDFs between models and observations can reveal some differences. Thus, the normalization of the PDFs. In order to do that we divide each bin by the sum of all bins, or in other words, by the sum of all data considered to build the PDF. To avoid confusion, we decided to change “sum of all bins” to “sum of all data considered as input for the PDF”.

RC1: Lines 172-173. Please better explain the statement: “Nevertheless, it should be noted that the Iberian overall value does not represent a mean from the spatial DAVs”

AC: What we meant here is explained in the prior sentences. The regional value in Figures 2 and 4 does not represent a mean from the spatial values in Figures 3 and 5 to 8. The first results from pooling together all data, and the later results from only pooling together the information within each low-resolution grid cell in order to compute the DAVs. To clarify the connection, we changed “Nevertheless, it should be noted that…” to “Therefore …”

RC1: Line 181. An end-phrase dot is missing. Whereas at line 182 there is a misplaced dot.

AC: Corrected.

RC1: Lines 183-186. These two statements are not clear to me.

AC: We thank the reviewer and changed these phrases to: “Contrasts are visible for both methodologies, where for precipitation intensity, the differences between the low- and high-resolution PDFs are more perceptible, particularly at bins below the percentile

thresholds. Thus, one can anticipate a generalised larger added value. On the other end, for precipitation frequency, and for the lower bins, the pdfs show a closer representation, almost overlapping, resulting in lower DAVs."

RC1: Line 205. What do you mean with "expressive"?

AC: We thank the reviewer for the suggestion and changed "… are more expressive…" to "…have an added importance…".

RC1: Line 209. "yet the same models reveal either maximum or minimum DAVs." It is not clear, please rephrase.

AC: Corrected. We change the statement "The overall DAVs are lower, yet the same models reveal either maximum or minimum DAVs." to "The overall DAVs are lower, yet the models reveal similar differences, with the same models showing maximum DAVs in Figure 2a also present in Figure 2b.".

RC1: Line 289. "the results do not necessarily have to agree." If we consider the same RCM driven by reanalysis.

AC: Corrected.

RC1: Caption Fgiure4. Please specify the tick blues line RCMs clustering as function of the different driving GCM.

AC: We thank the reviewer for the suggestion and added the following statement: "The thick blue lines separate the RCMs driven by different GCM."