

## **Review of "A regional climate simulation over the Iberian Peninsula for the last millennium" by J.J. Gómez-Navarro, J.P. Montávez, S. Jerez, P. Jiménez-Guerrero, R. Lorente-Plazas, J.F. González-Rouco and E. Zorita.**

The present manuscript presents results from climate simulations covering almost 1000 years with focus on the climate in the Iberian Peninsula. Comparison is made between a coarse-scale GCM and a high-resolution RCM that has downscaled data from the GCM. In addition, comparisons are made with observations and proxy-based reconstructions. The authors clearly demonstrates that there is a gain in downscaling the ECHO-G model for the modern day climate (1961-1990) when there are good observations to compare with. The improvements in the representation of regional scale details in the Iberian Peninsula implies that the method should be suitable also for other less well-observed time periods like most parts of the last Millenium.

A problem with the paper is that there is too little justification as to the choice of the ECHO-G model for providing boundary conditions. According to the comparison of results with observational data in the late 20<sup>th</sup> century the ECHO-G model appears to have some relatively large errors (the most important one is that it seems to be too zonal). In the result section there should be a better comparison of ECHO-G results to observed or proxy-based data. I realize here that a major problem is the lack of high-quality proxy-data at a high temporal resolution to compare the GCM simulation with. However, it should at least be possible to perform some evaluation of the large-scale circulation statistics including its variability in time over the last 100-150 years. Such a presentation would facilitate discussion of the results for the downscaling experiment. In addition to this more general problem I do have a list of questions and comments that I would like the authors to consider. The paper is well organized and easy to read. There are, however, potential improvements to be made in terms of the presentation, including the language as listed below.

### ***Specific questions and comments***

P2073,110-11

It is not necessarily so that the physical parameterisations are improved in a RCM compared to in a GCM. They can be, but it is not needed. Important here is that the higher resolution implies that some of the phenomenon (like synoptic scale disturbances) are better represented than in coarse-scale models.

P2074,114

Jacob et al is not about climate projections. Please exchange this reference to Déqué et al in the same special issue on PRUDENCE. Further, there is no reference made to ENSEMBLES here. A candidate would be van der Linden and Mitchell (2009).

- P2074,116 Another reference where RCM-data from paleoclimatological simulations for the last millennium can be found in Graham et al. (2009).
- P2074, 117 There are a number of studies for earlier periods. Renssen et al (2001), Kjellström et al (2010) and Strandberg et al (2010) are examples.
- P2074,123-27 Here I think you need a reference.
- P2074,128 “few climate reconstructions”. For which periods do you mean?
- P2076,1-2 It is stated that a flux adjustment was applied. How was this done? How large would the drift be without it? Is the drift due to model errors? Or, is it a drift from some initial conditions being not in equilibrium? How does it influence the results? In this section it would be good if you could comment on the initial conditions and spin-up in the model.
- P2076,111-15 Here you present changes in TSI with time and then you say that “... These minima drive three respective minima in the global near surface air temperature (SAT)”. Then you make a reference to Figure 10 which does not show SAT but rather SAT in the Iberian Peninsula. Either show a figure also of the global mean SAT or state explicitly that it is not necessarily so that an event in TSI has to show up in the SAT-series for a very small area (IP). That this is the case may be inferred from the fact that the 1050 minima in TSI does not show up in SAT.
- P2077,117 Be explicit about that you mean “long-term (30-year) seasonal means” if this is what you do (unless you compare time series of seasonal mean from individual years?
- P2077,18-19 Here you refer to the gridded observational data set usually referred to as E-OBS. I think you should write this and not ECA. You should also clearly state which version of these data that you have used. So far 3 versions has been released. You can also state already here that the data has been downloaded for the regular 0.25x0.25 degree grid (and not as now – at p2078, 12). Also, an acknowledgement (p2096, 15-9) would be appropriate (<http://eca.knmi.nl/download/ensembles/ensembles.php>). Use E-OBS instead of ECA in the rest of the document including figures.
- P2078,111-23 This part describes the reconstructions used but it does not say how the comparisons to your model were made. Did you use the same PC-regression as mentioned above for comparing simulations?
- P2078,113 Is it to be expected that the 0.5x0.5 degree data gives a good representation of the local/regional variability over the IP?
- P2079,15 I’m not so sure that the end of the sentence “and is commonly used for validation purposes” adds that much

- here. Either remove it or include some example of when it is used (e.g. Christensen et al., 2010).
- P2079,112-14 A third part here would be that there are differences in formulation between the two models; ECHAM4 and the ECMWF IFS model.
- P2079,115-18 I think it would be good to discuss also the ability of ECHO-G to represent the large-scale circulation already at this point and not wait until the summary of 3.1. The presented biases in ECHO-G indicates that it is too zonal (warm winters and cold summers). Is this the case? And, in that case, what is the implication of this for the paleoclimatological application???
- P2080,111-14 In which simulation is there an overestimation?
- P2080,114-24 Yes, this may indeed be a random feature. But, it may also be that ECHO-G is too zonal on average (see also comment P2079,115-18).
- P2082,19-11 Is there no study on this for ECHAM4 that could be cited? Other downscaling studies have been discussing this (Graham et al., 2008).
- P2082,112 In this section it is not always clear what kind of variability you are referring to. Possibly change head line to “Temporal variability” if this is the case and then be more explicit about it. An example would be adding “inter-annual” before “variability” and “time” before “series” on P2083,113-14 and adding “temporal” before “variability” on P2083,11. Also in the last summarizing paragraph of this section it should be made more clear.
- P2086,12 “a good agreement” to what?
- P2086,18-9 “Thus, it can be expected ...”. I would suggest adding something along the lines “... given that the LBCs are at least relatively good” at the end of this sentence.
- P2088,15-7 Again, this may very well be due to internal variability (see comment P2076,111-15 above).
- P2088,18 Add “the global and regional” before “simulations”
- P2088,126 Add “statistically” before “significant” if this is what you mean here?
- P2089,11 What do you mean by “this relationship”? Is it in relation to earlier studies? Or, the relation between SAT and precipitation?
- P2089,14 Suggest adding “This is also the case for the past climate.” between the two sentences.
- P2089,117-18 Please be explicit about what these “warming patterns” are representative of. Is it the 21<sup>st</sup> C?
- P2090,19 What do you mean by more “complete parameterisation of sub-grid physical processes”? See also my comment P2073,110-11 above). Suggest changing to “better representation of ...”.
- P2090,111 What is the “component of internal variability due to the RCM itself”?

- P2090,124 “show similar variability”. On what time scale is this? Can you be more quantitative here? Is the similarity in variability significant in a statistical sense?
- P2091,11 “in the cold periods is not good”. Which cold periods? The simulated ones? There are hardly any cold periods in the proxy-based data ... at least not in summer.
- P2091,19-10 The fact that “summer precip variability is overest” is that as absolute precipitation is overestimated? Or, is it a too strong variability also in a relative sense?
- P2091,121- This part is about the relation between NAO and precipitation in the recent past climate. It is not clear if the numbers are referring to MM5 data? ECHO-G data? or, even observational data? Please be more specific about this. And, also I think it would be interesting to compare this relation in all three data sets. I.e. can MM5 simulate precip vs NAO-index in line with observations? Is there an improvement to this relation in MM5 vs ECHO-G? This should be done already in Ch 3 and is important in context of the comparisons to reconstructions made here in Ch 4.2.
- P2092, 15-6 How important is this? Can you be more explicit about how large fraction of the variance that is explained by the relatively weak correlation (-0.4)?
- P2092,111-13 It is certainly OK to calculate the index based on AOGCM data as the RCM SLP tends to follow that in the AOGCM pretty well. But, you could state that in a sentence referring to how good the agreement between the two is in your case.
- P2092,118-19 Please give numbers here “a clear anti-correlation”, “anti-correlation is less apparent”.
- P2093,15-20 I have some problems following the logic here. The argument is that if simulated NAO is in phase with the observed one then one should be able to compare simulated and observed (reconstructed) precipitation. The problem is that the information about NAO is based on reconstructions of precipitation. Therefore, to my mind, this section includes a circular argument that needs to be better explained.

I also have some problems with the two reconstructions cited and how these can be compared/used. The first (by Trouet et al) is a reconstruction of NAO that is based on two different proxies for precipitation (drought in Morocco for February-July and speleothems in Scotland for annual precipitation) and the second (Pauling et al) that is a precipitation reconstruction based on both documentary data and a number of different proxies. I would like to see a more elaborate discussion on the uncertainties in these reconstructions (what seasons do they represent? What temporal resolution do they have? Are there any dating

	problems?) and the implications of those uncertainties on the conclusions made here.
P2094,19-10	Which model is referred to here? MM5? In that case, what is the internal variability of the model?
P2094,111-20	How can you be so sure that these TSI changes drive the climate over the IP? How large are unforced variations in T&precip for this region in control runs with ECHO-G? See also comment P2076,111-15 above.
P2095,12-3	Here again it is stated that the “more complete physical parameterisation of sub-grid scale processes”. See earlier comments (e.g. P2073,110-11).
P2095,116	On line 16 it says “differences between both results”. It is unclear what is meant by “both” here. Is it between the RCM precipitation and the Trouet et al reconstruction? Or between the RCM precipitation and the Pauling et al reconstruction? Or, something else?
P2116	In Figure 14 you show the entire IP. Previously you say that the precipitation responses in the N&S are quite different. Would the picture be different if you showed the corresponding time series for any of these regions instead?

### ***Detailed comments on language***

P2072, 15	Exchange “experiments” to “models”
P2072, 118	Remove a “t” from “Jonest”. Also 2073, 11 and in the reference list.
P2072, 120	Change order “the of” into “of the”
P2073, 14	add “to” after “due”
P2074, 18	Change “Circulation” into “Climate”
P2074, 19	Add “as” after “equations”
P2074, 118	Remove “the” after “this”
P2076, 18	Remove “the” after “in”
P2076,119	Change “both” into “all”
P2077,110	What is “RRTM”?
P2077,111	What is “MRF”?
P2078,114	Change “on” into “of”
P2079,12	Add “for MM5” after “study”
P2079,111	Possibly change “is noticeable” into “stands out”?
P2079,118	There is no Figure 2a. Remove “a” or add “a” and “b” to the figure.
P2079,121	Change “Fig. 2” into Fig. 3”
P2080,126	Change “four” into “three” or use “four model integrations”
P2081,12	Change “have been previously” into “have first been”
P2081,19	Change “simulations” into “comparison with observations compared to the global model”
P2082,12	Add “the” after “amplitude of”
P2083,118	Add “with” before “respect” and “partly” after “to”
P2085,15	Add “first” between “the EOF”

- P2085,118 Consider changing “in this case” into “for precipitation as compared to SAT”
- P2085,122 The sentence “... as corresponds to a system weakly forced ...” does not read well. Please reformulate it.
- P2085,125 Consider changing “pretty similar ... respectively” into “close to each other, c. 13% in both”.
- P2085,129 Consider changing “obey to” into “follow”
- P2087,126 Here, and later you refer to certain events by name (and year). I think it would facilitate for the reader if you marked these periods in the figures you are referring to (for instance by a horizontal bar above or below the time series and/or with thin vertical lines through the time series).
- P2089,12 Consider changing “positive tendency” into “positive correlation”
- P2089,119 Change “models” into “the two simulations”
- P2089,120 Remove “implemented” and “as can be seen in “
- P2089,128 Change “averaged” into “average”
- P2090,115 Change “circulations” into “flow patterns”
- P2090,121 Remove “the” before “Fig. 10”
- P2092,11 Change “in the” to “on” before “winter”
- P2092,12 Remove “s” in “correlations”
- P2092,125 Remove “the” before “Fig. 10”
- P2092,126 Remove “the” before “NAO” and before “precipitation”
- P2093,11 Move “in principle” before “we should”
- P2095,127 Remove one “the”

### ***Detailed comments on Figures***

- Figure 1 It is not easy to get an idea of total forcing here as it is difficult to add volcanic and TSI forcing in a simple way given the different scales. It should be explained why the TSI curve look so different before/after c. 1725.
- Figure 2 Say explicitly that blue colors represent ocean grid boxes.
- Figure 6 What is the unit?
- Figure 7 What is the unit?
- Figure 10 Here you use Kelvin instead of Celsius as is previously used. Be consistent. I took me some time before I found the very small figure explaining the NW and SE domains. I suggest you add a sentence on this in the caption. An alternative would be to merge this panel (and enlarge it) into Figure 2.
- Figure 13 What are the units? Also, same comment on NW and SE as in Figure 10.
- Figure 14 Here is an example where it would be most useful to add a bar showing the extent of for instance the Maunder minimum. The green line is lacking in the legend. Further, it is evident that the temporal resolution in the green line is different to that in the other ones. Please make a comment on this. Plausibly you could plot also the red and blue lines filtered in a similar way to facilitate comparison.

## **References**

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