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Climate of the Past Discussions

Interactive comment on "Spatial climate dynamics in the Iberian Peninsula since 15 000 Yr BP" *by* P. Tarroso et al.

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Reviewer's comments in italics.

1) page 3903, Introduction; page 3906, Methods and other: The authors do not include in their analysis the last 3000 years. This they explain is because of the influence of anthropogenic disturbance on the vegetation, which has disturbed the equilibrium state between vegetation and climate over the last 3000 years. However, the authors also use the modern vegetation distribution to calibrate their transfer function, despite the modern period having had probably the greatest human impact on the vegetation. They then also highlight the role of future climate change as having an important impact on future vegetation distribution rather than being dominated by even greater human impact. The authors seem aware of the contradiction but it nevertheless seems to

somewhat undermine the justification for their methodology. While the calibration of the pdf transfer function based on modern vegetation occurs at continental scales where climate is probably dominant, the transfer function will in actuality be more heavily reliant on the vegetation distribution of the study region, since this is where the closest analogue vegetation/climate is to be found. Part of the problem here is that the authors do not assess the robustness of their pdf method (see point 6).

REPLY: The reviewer poses an interesting and common critique to the method. Nevertheless, this contradiction is very illusive. Gathering distribution data at macroecological level allows to decrease the anthropogenic influence on the distribution as well as other microecological factors that might determine plant presence at smaller spatial scales. Removing presence data with anthropogenic origin is also performed to further decrease the human influence on distributions (Kuhl et al 2002). This was performed using information on atlases and the data on the GBIF tables (e.g. remove presences on botanical gardens). These presences are usually very sparse. However, a main point of gathering these data is to build the PDF that best depict the climatic tolerances of the species. The main disturbances result from planting species outside their natural range or removing trees and/or populations from their natural range. It is known that distribution data from invasive ranges can be also used to better depict the niche tolerances (Broennimann and Guisan 2008). Thus, using full distributions at coarser spatial scales (for instance, 0.5°) is likely providing a good estimation of the niche. In the second case, removing species from their natural range, might reduce the climate envelope if the disturbance is very important but this does affect the overall climate range under which the assemblage is found. The reconstruction is performed per taxa, meaning that no analogues have to be found. The presence of the taxa in the pollen assemblage will indicate a similar climate. Multiplying this with all the taxa found in the pollen assemblage, we can get a likely value for the climate. We assume that presence of a particular taxa in the pollen assemblage during the last 3000 thousand years might be less related to climate and may be of anthropogenic origin. Due to this fact, we do not provide climate estimations for this period as they would likely be biased. By using

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the pollen taxa present we also assume that local conditions are reflected in the combination of the taxa present. Therefore, we gathered more data on the Mediterranean species to achieve better reconstructions in the Iberian Peninsula. This will be better described in the revised version.

2) page 3906, Data Sources: The authors apply the PDF approach by georeferencing the distribution of 246 taxa from Flora Europaea and the Global Biodiversity Information Facility. It is not clear how these botanical taxa were matched against the pollen taxa used in the reconstruction. They need to include a table providing a list of pollen taxa and their botanical taxa equivalent used in the calibration. Without this information it is impossible to see how this took place, and to be able to potentially reproduce this aspect of their methodology. There are many problems that are likely to be associated with this, particularly since many pollen taxa are only resolved to genus or family level, and this needs to be shown.

REPLY: A table showing all taxa used will be added to the revised version.

3) page 3907: The authors reconstruct 3 climate variables. They need to explain why they chose these three particular variables, since they are not commonly (have ever been?) used in pollen-climate reconstructions. They also need to explain what these variables are; "January minimum temperature" for example, is this the mean monthly minimum, or the lowest ever recorded in this month?, "July maximum temperature" , is this the mean monthly maximum, or the highest ever recorded in this month?, "Minimum annual precipitation" what is this? The lowest mean monthly precipitation recorded in any month? Or the lowest ever? And why is it described as annual? Very confusing and not at all clear why this is preferable to the much more commonly used mean annual precipitation, or moisture balance. Following on from this, it is also confusing to then refer to these variables as Tjul, Tjan since these are usually used to denote mean monthly values, and Pmin is similarly confusing. Try and choose something a bit more self-explanatory. Problems with the chosen climate variables also extend to the discussion, where these are used much too loosely in discussions

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of warmer/colder and wetter/drier conditions. For instance, 3913, 17-22, the authors talk about precipitation values showing more humid conditions, but is this appropriate given that the reconstruction is for the driest month only (if this is really what was reconstructed). For instance, what if the mean annual precipitation increased but the driest month got drier? We then have wetter conditions on an annual basis, but drier conditions for the one month. Similar on page 3914, lines 20-25.

REPLY: The variables were chosen due to their likely influence on plant distributions. The temperature variables follow the same nomenclature as the climate data source (http://www.worldclim.org/; Hijmans et al. 2005). We assume that the precipitation variable name can be misleading. As the reviewer suggests, this is the precipitation of the driest month. We will change the text accordingly in the revised version.

4) 3907, 11-12: You need to explain which software was used for the PDF analysis, and state precisely which method. Is this a direct reproduction of a previous method using the same software, or something new or adapted? Following from point 2, you seem to have added additional taxa information, if not additional taxa. Also, why did you choose to use the PDF method and not other more commonly applied methods such as modern analogue? There are certainly known weaknesses in other methods, what are the strengths and weaknesses of the PDF method that led you to choose it over other methods?

REPLY: We have developed the code in R language to apply the method. This code will be available soon. The pdf-method uses presence data and does not rely on modern analogues, thus, it is not dependent on the availability of modern analogues, neither it depends on modern co-occurrence of taxa (Kuhl et al 2002). It generates a most likely reconstructed values with its uncertainty (Kuhl et al 2002). Adding more taxa allows to use the full spectrum of presences found in the pollen assemblage and, thus, achieve better reconstructions. As said in point 2, the taxa list will be available as a table. We will add this information to the text.

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5) 3907, 16-17: We need to know how the pollen sum was calculated since the percentage values appear important and are strongly influenced by what is included in/excluded from the sum. For instance, a standard sum based on total terrestrial taxa, or just the taxa used in the transfer function? (see point 2).

REPLY: The reconstruction is still based on the presence of the taxa. We added a filter to the PDF based on the pollen proportion. This proportion is calculated as the proportion of pollen counts for a depth/age in relation to the maximum pollen counts found for that particular taxa. We use this to avoid the issues resulting from the different pollen quantities produced by each species. The transfer function is taxa based and not assemblage based. Thus, we use all taxa available at a particular depth sample and for which we have distribution data. We will change the text to better explain this.

6) 3908: A serious failing of the whole analysis appears to be the lack of any evaluation. How reliable is the reconstruction? What have you done to evaluate the method and what evidence is there to support the robustness of your reconstructions? Can you provide some form of evaluation using modern pollen surface samples for instance? Or perhaps provide some direct comparison of other reconstructions for the study area based on other proxies and/or pollen-based studies? Interpolation uncertainties are shown in figure S2, but no reference is made to reconstruction uncertainties. The time series area-averages shown in figure 5 are a combination of reconstruction and interpolation uncertainties, but these are not acknowledged.

REPLY: As said above, we do not expect that the modern surface pollen distribution is purely affected by climate. Human has changed the landscape at this level at it is reflected on the pollen surface samples. Reconstructions using these data would not provide a good evaluation of the method. As the reviewer suggest, we can add a comparison with other reconstructions to better evaluate the model. We will add the uncertainty to the reconstructions.

7) page 3909: How were the time windows calculated? For example, by averaging

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all the samples within a time frame eg 11,000 +/- 500 years BP? Or by choosing the sample closest to the target time eg 11,000 BP? Or by interpolating to the target time.. Please explain. Also, how were the individual age-depth models arrived at and how were 14C calibration issues dealt with?

REPLY: 14C dates were calibrated with Calib 7.0 (Reimer et al. 2013) using the calibration data set intcal13 (http://radiocarbon.pa.qub.ac.uk/calib/). Calibrated 14C dates were then used to build an age/depth model for each pollen series. The time slices we have used in this study correspond to an average of all samples included within an age +/- 500 years. This means that we may have either one sample or several ones that have been averaged within each 1000 years time span. The time frame windows were calculated by the thin-plate splines of the reconstructions. We will rephrase the text to make this point more clearly stated in the revised manuscript.

8) pages 3909, 3911, 3912: The interpolation is based on anomalies, but the results in the main figures are presented as absolute values, which are also the basis of the discussion. Why the use of absolute values?, and especially for area-average calculations? I can see how you might like to use these to make the maps look nicer, since it will help pick out the topographic features, but they are of little value to the average reader who is unfamiliar with (for instance) the area-average maximum July temperature of Iberia and simply wants to know the change relative to the present. Was it warmer or cooler or drier or wetter than today? This also allows us to compare with other studies both within and distant from the study region, and is particularly useful in this case because the reconstruction does not include the present day values of the climate variables.

REPLY: The absolute values of the reconstructed temperatures were preferred due to the direct applicability on a wide range of biogeographical studies. The figures and discussion will be adapted to anomalies in the revised version.

9) 3909: How was the interpolation done?, please describe. It looks like a 2- dimen-

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sional spline was fitted, since the interpolated anomaly maps are very smooth. If you had used a 3-dimensional spline you might have found that the interpolation un- certainties were reduced. Using a 2-d method assumes that lapse rates have been constant for the last 15,000 years, something that is extremely unlikely. Climate varies vertically as well as horizontally. Sites at different altitudes will undergo different temperature/precipitation changes relative to each other as a result of these lapse rate changes. The difference between your 'C1' region and the other regions probably reflects this (3912, 18-19), and using a 3-d interpolation would have highlighted this more.

REPLY: We will include the interpolation method and details as suggested.

10) page 3910: The maps shown in figure S1 and S2 need to be bigger, and the scaling easier to read with more numbers. Space is not limited in online materials so make the most of it, you have some interesting results here. The scaling of Figure S2 would be easier to read if it was monochromatic. What are the units of the 'variance' shown in figure S2 and how was this calculated? I am presuming this is the standard error of the interpolation generated by the spline (an output of the fields package), please state this. The text says that this is 'low', although the values in figure S2 actually look very large compared to the changes in the Holocene shown in figure 5, again uncertainties need to be considered.

REPLY: The figures will be adapted accordingly to reviewer suggestions in the revised version.

11) pages 3912, 3913: The discussion talks about climate change in terms of values, but not in terms of climate itself. There are some interesting results here, what is causing them? How and why did climate in the past potentially differ from that of the present? The role of the Atlantic and Mediterranean, the interaction of air masses, the trajectory of the winter storm tracks, the strength of the westerly circulation, continentality etc? There is one attempt where the authors state that the increase in summer

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insolation from 15k BP was the cause of the observed increase in winter temperatures (3912, 11-12); but how could this be so?? And why no change in summer temperatures? This the authors appear to explain by some kind of physiological upper limit to the growth response to temperature (3913, 4-5), but how and why? Does this mean that we cannot reconstruct summer temperature from vegetation beyond a certain limit? The authors also appear to explain the increasing variability of minimum January temperature after 14k as a result of the expansion of trees, which modified albedo (3913, 27-28); how and why do trees/albedo increase winter temperature variability on this timescale?, and how are alternative explanations discounted? It is not clear from the cited reference. Similar on page 3915, line 1; how and why does human impact cause lower temperatures, and why can other reasons be discounted?

REPLY: The discussion will be restructured to include the reviewer suggestions in the revised manuscript

1) 3904, 7: at the molecular

REPLY: Done

2) 3904, 10: predicted for future decades

REPLY: Done

3) 3910, 8-10: Please state more clearly what software was used for what analysis

REPLY: Done

4) 3913, 4-5: "are likely resulting in non-responsive July temperature" what does this mean?

REPLY: Rephrased

5) 3913, 10, 12; 3914, 2 etc: 'OD', 'BA', 'YD' etc acronyms need to be defined

REPLY: Done

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6) 3915, 28: precipitation was

REPLY: Done

7) Table 1: Please include site altitude, number of 14C dates (or other absolute dates)

REPLY: Done

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