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Climate of the Past Discussions

Interactive comment on "Hydrological evidence for a North Atlantic oscillation during the Little Ice Age outside its range observed since 1850" *by* C. Martín-Puertas et al.

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We thank Anonymous Referee 1 for the comments on our manuscript and we address the most relevant questions below:

DATA TREATMENT AND METHODOLOGY

The referee thinks this part is VERY weak and is presented in a very meagre way. However, our intention was to provide the most relevant information while avoiding an excision in technical details, which might be too specific for the wide scope of readers of Climate of the Past. So, detailed descriptions of methods already published (for instance related to the isotope analysis) are referred to specific publications. Neverthe-

less, we will show all the methodological details in a revised version since the referee considers this information pertinent.

We would like to clarify the specific comments by the referee1 (R1):

R1: Line 23 "Four of the collected. . .": Why do you take only four cores? What are your criterions to choose them?

Usually, the amount of samples to build a reliable isotope chronology is between 4 and 5 trees (Gagen et al., 2004, 2007; Leavitt, 2010; Leavitt and Long, 1984; Treydte et al., 2001). The pool chronology was built with 4 samples, which were selected based on time-span, feasibility for splitting the tree-rings and correlation with the other cores. The stable isotope chronology of the present study is a combination of pool and individual measurements. Thus, for the individual analysis, in order to avoid the effect of inter-tree variability, we analyzed individual tree-rings in samples taken from the same four trees used for the pool. Specific details are shown in Dorado Liñan et al (2011).

R1: The way the final chronology was built is unclear. Do you use different trees for the pre-1600 and post-1600 time period? If it is the case, you did not use only 4 trees. Why not using the same trees for the whole time period if 900-year old trees exist as stated in line 19? If it is not the case, I do not understand how you can have trees overlapping in the 1400-1600 interval. . .:

We used different trees for the pre-1600 and post-1600 time period because the trees older than 500 years found in the Cazorla forest show very thin and often several missing rings during the recent centuries. Splitting the tree-rings was thus not possible for the most of these trees. In the rare cases where it was possible, the material left after cellulose extraction was not enough for isotopic analysis. Therefore, it was necessary to take samples from 'younger trees' (still older than 400 years old).

R1: Do you separate early from late wood?

No, we did not because of technical limitation. As it is mentioned above, tree-rings

are very thin and the separation between these two fractions of wood is practically not possible.

R1: How do you deal with the d13C decline of atmospheric CO2? Are your data corrected?

Yes, they are and we agree with the referee that the correction should be shown. The δ13C was corrected for the increase in atmospheric CO2 by subtracting the annual changes in δ13C of atmospheric CO2, obtained from ice cores and direct measurements (Elsig et al., 2009; Leuenberger et al.,1992). Details and values can be found at Leuenberger, (2007) and McCarroll and Loader,(2004)

R1: Did you test some PIN correction? How would it affect the results?

We did not apply the PIN correction because our data is partly based on a pool chronology and PIN correction needs to be applied on individual trees. Besides, long-term changes of the atmospheric δ13C source value affect all trees equally, however, individual trees may respond differently to changing CO2 concentrations. Hence, no correction was adopted for potential impacts of the increasing atmospheric CO2 concentration on the carbon isotope fractionation during photosynthesis such as the PIN correction (McCarroll et al., 2009; Treydte et al., 2009).

R1: What about juvenile effect on d13C? What part of the chronology can be affected by such age effect? To what extent?

The first 60 years of each sample were not used to avoid the juvenile effect. Furthermore, the possible long-term age effect on the stable carbon isotopes series at the Cazorla sites was previously tested in Dorado Liñan et al (in press). In that study, no significant differences in the climate signal recorded by trees in different age classes were found at the Cazorla site.

R1: Page 4154 Line 28: Why do you choose June-to-September? Is it the growing season? The combination of months which give the highest score? Please justify.

There is a short explanation between lines 16 and 24 of the same page. The selection of this season is not solely based on the correlation coefficient; it also has a physiological meaning. The significant negative correlations with June, July, August and September rainfall denotes a certain degree of water stress. In summer, high temperatures promote high evapotranspiration rates which may also increase with more rainfall, affecting directly the isotope fractionation and resulting in a negative correlation between δ13C and precipitation.

R1: Page 4154 Line 4: "the results show strong . . .": 0.4 is not what I would call strong. It is rather moderate. What are the p-values? The results shown in figure 3c are not very convincing.

We will add the p-value in table 1. We consider that the correlation between the Cazorla stable carbon isotope chronology and the June to September precipitation data is high enough to perform a reconstruction. The quality statistic of the reconstruction and the confidence intervals are provided reflecting its reliability.

REFERENCES

The referee considers many references are inappropriate and shows some examples. However we disagree:

Rodrigo et al., 1999 and Rodrigo et al., 2000 use documentary data from 1501 to 1850 and show dry periods during 1501-1589 and 1650-1775. Barriendos, 1997 distinguishes between drought above average during 1722-1881 and rogations above average during 1761-1801, both indicating drier conditions during the Maunder Minimum. Nicoult et al, 2008 develops a network of PDSI reconstruction based on tree-rings for central and south Europe. The PDSI reconstructions from the Iberian show two main dry periods: 1450-1670 and 1760-1900, the latest is during the Maunder Minimum. Moreover, since the year 2000 new documentary data have been published; for instance, the last and most complete compilations of documentary data published in 2010 and 2011 by Dominguez-Castro et al. (Climate of the Past and Climate of the

Past Discussion), which includes the data by Barriendos, (1997) and Rodrigo, (1999, 2000) and covers the whole Spain reporting widespread Iberian and Atlantic droughts during the Maunder Minimum.

Moreno et al., (2011) show a compilation of terrestrial and marine records covering the entire Iberian Peninsula (the Mediterranean and Atlantic basin and the North, central and South Spain).

Morellon et al., (2011) show data from Southern Pyrenees and actually we use this reference to discuss the hydrological differences between the Pyrenees and the rest of the Iberian Peninsula in Page 4156 Line 24-27 and Page 4157 Line 1-2.

In Page 4156 Line 7, Moreno et al (2011) and Morellon et al (2011) are cited to provide evidence of the hydrological signal during the MCA-LIA transition in the southern Europe at multicentennial timescale, but not to compare with the studied site within the LIA.

R1: Page 4157 Line 19: Zveryaev et al. (2008) does not refer to the East Atlantic pattern but to the Scandinavian teleconnection pattern!

The first sentence of the second paragraph in the abstract by Zveryaev et al. (2008) says: “The first and second empirical orthogonal function (EOF) modes of winter PW over Europe are associated, respectively, with the North Atlantic Oscillation (NAO) and the East Atlantic teleconnection pattern”. It is exactly what we say in Page 4157 line 19.

METHODS AND RESULTS

We propose to restructure the Methods chapter and consider the precipitation reconstruction as part of the Results in order to distinguish clearly both chapters.

Interactive comment on Clim. Past Discuss., 7, 4149, 2011.