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Climate of the Past Discussions

Interactive comment on "Maximum growing season temperature in Western Europe: multi proxy reconstructions in Fontainebleau from 1596 to 2000" *by* N. Etien et al.

N. Etien et al.

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Answer to J. Luterbacher' review

1. Page 1065, 2nd para: This para is rather unspecific and also the chosen references are mixed, some referring to annual NH recons, others European seasonal ones. Why not mentioning just those which are potentially of importance for your larger area, ie. Those with a European or sub continental context? (Briffa, 1988; Luterbacher et al., 2004, 2007; Chuine et al., 2004; Guiot et al., 2005; Meier et al., 2007, among others).

Initial version: Several attempts have been made to quantify European temperature changes during the past centuries (Overpeck et al., 1997; Jones et al., 1998; Mann et al., 1998; Crowley, 2000; Briffa, 2000; Briffa et al., 2001; Esper et al., 2002; Luter-

bacheret al., 2004; Guiot et al., 2005; Moberg et al., 2005).

It was changed as follows: Corrected version: At the European scale, several attempts have been made to quantify temperature changes during the past centuries (Briffa et al, 2002; Chuine et al., 2004; Luterbacher et al, 2004, 2007; Xoplaki et al., 2005; Guiot et al, 2005; Büntgen et al, 2006; Meier et al., 2007).

2. What are ancient instrumental data? Early instrumental data? Also on page 1088 Change historical records, also at other places to documentary evidence (see Brazdil et al., 2005 for a review)

We agree that "early" and "documentary evidences" are more appropriate. Initial version: These European-scale reconstructions are mainly based on ancient instrumental records, high latitude or altitude tree-ring growth indices, and, sometimes, historical records. Corrected version: These European-scale reconstructions are mainly based on early instrumental records, high latitude or altitude tree-ring growth indices, and, sometimes, documentary evidences.

3. However, many regions are... I am not sure about this statement. The climate of a region can sometimes be reconstructed accurately with teleconnection information and not always local information is needed. So what you possibly mean is that in some reconstruction only scarce information is included from France.

That is indeed what we meant. We made the following correction: Initial version: However, many regions are not represented in these quantitative reconstructions of recent temperature variations, such as temperate climate areas of France. Corrected version: The spatial coverage of proxy records is important due to specific regional signatures of extreme events such as the 2003 extreme heat wave (Beniston, 2004). However, in these quantitative reconstructions of recent temperature variations, only scarce information from the temperate climate area of northern France is included.

4. Same page, last para, line 22. Apart from the Guiot et al. 2005 reference there are

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others that are of importance in this context as well and should be cited. My suggests would be: Buentgen et al. 2005; 2006; Frank and Esper, 2005.

Initial version: Although tree-ring densities and/or widths have been successfully used to reconstruct summer temperatures in high latitudes or altitudes where temperature is a limiting factor controlling tree growth (Briffa et al., 2001; Guiot et al., 2005), they do not provide reliable reconstructions of temperature in temperate areas, where tree growth reacts to a variety of environmental factors. It was however shown that Quercus sp. ring width may be partly controlled by drought (Briffa, 2000).

Corrected version: In high latitude or high elevation, tree-rings widths and maximum densities are sensitive mainly to summer temperature and can therefore provide reliable reconstructions of this parameter (e.g. in Europe: Briffa, 2002; Frank & Esper, 2005; Guiot et al., 2005; Büntgen et al., 2005, 2006). At the contrary, in low elevation temperate areas, tree growth is affected by several factors. For instance, ring-widths were shown to be controlled by drought for Quercus sp. (Briffa, 2000) and to depend largely on precipitation for Fagus sylvatica L. (Dittmar et al., 2003).

5. Page 1066: Line 14 and also page 1077, line 16, better mean air temperature or mean 2m temperature.

Initial version: The harvest dates of "Pinot Noir" grapes in Burgundy (eastern France, ˜250 km south east of Fontainebleau) were also shown to be a proxy for the mean atmospheric temperature of April to September (Chuine et al., 2004) and have inter-annual variations strongly related to Fontainebleau maximum temperature from April to September (Etien et al., submitted). The harvest dates of "Pinot Noir" grapes in Burgundy (eastern France, ˜250 km south east of Fontainebleau) were shown to be a proxy for the maximum atmospheric temperature from April to September (R = -0.71) (Etien et al., submitted). Corrected version: This paragraph was changed. In the introduction, one can find now: "In temperate areas, grape harvest dates (GHD) series are another annually resolved proxy for spring-summer air temperature (Chuine et al.,

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2004)."

In section 2.3.: The harvest dates of "Pinot Noir" grapes in Burgundy (eastern France, ˜250 km south east of Fontainebleau) were shown to be a proxy for the maximum air temperature from April to September (R^2 = 0.50) (Etien et al., submitted).

6. Line 24, I am not a tree ring specialist but 15 living trees seems to be too few to do a robust statistical analysis ?

We have made this point clearer in the revised version. Initial version: Homogenised instrumental records of maximum monthly temperature are available in Northern France for the past century, as well as documentary records of grape harvest dates and proxy records of seasonal climate obtained by the analysis of latewood tree-ring cellulose isotopic composition (d18O and d13C) from 15 living trees (Quercus r.) sampled in the Fontainebleau forest. Corrected version:

Latewood tree-rings formed in the same calendar year were pooled together. In contrast with the large number of tree samples required to build dendrochronological master series, a short number of samples is appropriate to produce a regional δ18O signal. Etien et al (submitted) have shown, indeed, that owing to a great inter-tree coherency, the pooling of only three oak-trees late wood was enough to generate a consistent and reproducible signal.

7. There is a new April-August temperature reconstruction for Switzerland published by Meier et al. (2007). In my opinion, it would be nice to do a comparison between this new grape harvest record from Switzerland covering the last centuries.

The comparison with Meier et al.' s data was made and commented in the new section 4 devoted to comparisons with other Western European temperature reconstruction. See also the new figures 5a and 5b.

8. Page 1067, line 17. I do not understand what you mean with -without any standardization-

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The data we use for the calibration are raw data. They do not need any preliminary standardisation, as those necessary for age trend correction for instance. The sentence pointed out by J. Luterbacher does not exist anymore in this section (which has been re-organised). Some equivalent can be found in the conclusion (see below). Initial version: The originality of this analysis is the use of raw tree ring isotopic data, without any standardisation: we take advantage of the annual resolution of the records and assume limited age effects. Corrected version: By contrast with "classical" dendrochronology, we have not deployed sophisticated statistical data treatment to combine different tree sets; and contrary to many other temperature reconstruction methodologies, we have used continuous and homogeneous proxy records.

9. Line 23. I think the argument that Guiot and our reconstructions can be improved in this context is not correct. In the reconstruction of Luterbacher et al. (2004, 2007) and Xoplaki et al. (2005) we are doing monthly to seasonal estimates. Also Guiot et al. Provide summer reconstructions, therefore an April to September proxy will not help us to improve the reconstruction skill. So I would suggest to remove this sentence or the references.

The guilty sentence was removed

10. Page 1077: also figure 2c ff. From what I can see and interpret, you do not present missing values in the Burgundy grape harvest dates. Looking at the Chuine et al. 2004 and Le Roy Ladurie et al. 2006 data series (also at the NOAA paleo homepage), there are a couple of missing values in the whole series. So I am wondering whether you filled those gaps or if you set them to the long term mean? Please add those important information. In the Chuine et al. (2004) series, which can be found at the NOAA page ftp://ftp.ncdc.noaa.gov/pub/data/paleo/historical/france/burgundy2004.txt, there is only one missing value: 1978. The gap was filled recently thanks to E. Le Roy Ladurie. This point was specified in the paper. Corrected version (in § 2.3) "This Burgundy series is available since the late 16th century without missing data (Chuine et al., 2004 and Le Roy Ladurie, pers. comm. for 1978)".

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11. As mentionned above, here a comparison with the Swiss grape harvest dates (Meier et al. 2007) should be performed to have an indication about the connection between the two areas both in the instrumental period, but also for the period based on the same type of proxy only (pre instrumental period). Both an overall correlation but also a moving decadal correlation plot would be helpful to see whether the relationship is stable over the time or not. A discussion on this issue would help. Maybe you could also add the uncertainties from both reconstructions.

The Meier et al.'s data have been introduced in the paper, and compared with the reconstruction at Fontainebleau (figure 5a). We have also added a comparison of the correlation coefficients calculated over century time periods (figure 5b). In section 2.3. few words have been added to compare Burgundy and Swiss Grape Harvest Dates:

"It is quite coherent with grape harvest dates from Switzerland (Meier et al, 2007) (R^2=0.55 between Burgundy and Swiss GHD, from year 1599 to 2003), as expected from the spatial coherency of summer temperatures in Western Europe (Etien et al., in press)."

Section 4 deals with comparison of our reconstruction with other European Temperature reconstructions. In this section, the § dealing with Meier et al.'s reconstruction is as follows: Corrected version:

As a matter of fact, a good and persistent correlation is obtained between our reconstruction and Tmean AMJJA based on Swiss GHD (Meier et al, 2007) (R^{2}~0.45 except in the early 20th). Despite differences in the relative magnitude of cold and warm decades, the Meier et al.' s reconstruction exhibits centennial variations, with mild temperatures in the 17th century, cold decades in the 18th century and 19th century, quite similar to those of our reconstruction (Figure 5a).

12. You report on a negative correlation of 0.7 between Burgundy grape harvest and max temp. So you can explain around 50% of the variability. I was wondering whether this uncertainty is also included in your final reconstruction? Related to the point of un-

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certainties, I am not sure if I understood everything clearly enough. From your abstract you state that those uncertainties are of the order of half a degree. I dare if you really took into account all the uncertainties within the whole reconstruction procedure. For instance the uncertainties from documentary proxy evidence are not quantifiable, also there are other uncertainties in the tree rings which I did not find here but that have been recently addressed by Esper et al. (2007). In Meier et al. (2007) we address other sources of potential uncertainties that cannot easily be quantified. A discussion on those issues are needed. Therefore, I really advice you to quantify all possible uncertainties (including uncertainties in the instrumental data as well as based on the statistical calibration, i.e. unresolved variance), report on them and also discuss other uncertainties not quantifiable related to all the proxies.

The uncertainty issue is completely re-adressed in the new version. §3.2. untitled: "Calibration methodology and uncertainties" details the uncertainties on each proxy and on the final reconstruction. Taking into account various sources of errors we calculate a +/-1.1°C (1.5 sigma) uncertainty on the multi-proxies reconstruction. Corrected version:

The uncertainty associated with the linear model is estimated using a bootstrap method. Two thirds of the data (calibration samples) are randomly sampled with replacement; the best multiple linear regression is calculated on these data and the quality of the reconstruction is assessed on the last third of the data (verification samples). The uncertainty is obtained using the standard deviation of the verification residuals. After 1000 iterations of this method, we estimated a +/-0.55°C uncertainty on the linear model. Further uncertainties on the reconstructed Tmax AMJJAS may arise from the physiological response of latewood d18O and GHD to temperature changes (deviations from a linear relationship), from the uncertainty on the proxy measurements and from the uncertainty on the pre-1950 temperature observations. Our analytical protocol warrants an uncertainty on each annual d18O measurement within +/- 0.25 permil; the number of pooled samples ($>$ 3) also warrants that the effect of individual

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tree on the averaged annual d18O should be within +/- 0.5 permil (including the analytical uncertainty). Our estimate for GHD suggests an uncertainty of three days on the stacked Burgundy record. We have used the bootstrap method to test the quality of the linear regression model, taking into account these uncertainties on the proxies by randomly modifying the proxy data within their uncertainty range. In this case, the standard deviation of the residuals obtained over verification subdatasets is +/- 0.73°C (1000 iterations). Therefore, 85% of the residuals lie within +/-1.1°C (1.5 sigma). In order to have a conservative estimate of the quality of the reconstruction, we consider the error on Tmax AMJJAS to be +/-1.1°C for one year, and thus +/-0.35°C for a decadal (11 year) average. This type of uncertainty is comparable to the one obtained in Switzerland by Büntgen et al (2006) who combined more than 80 individual tree ring maximum densities using a regional curve standardisation method.

After this paragraphs one can find a discussion (two long to be reported in this accompanying letter) about the other, not quantifiable, sources of uncertainty.

13. Page 1086, Line 10, please also cite here Xoplaki et al. 2005 and Luterbacher et al. 2007

This paragraph has been rewritten and the sentence mentioned here by J. Luterbacher was transferred into the introduction were it becomed: "At the European scale, several attempts have been made to quantify temperature changes during the past centuries (Briffa et al, 2002; Chuine et al., 2004; Luterbacher et al, 2004, 2007; Xoplaki et al., 2005; Guiot et al, 2005; Büntgen et al, 2006; Meier et al., 2007)"

14. Line 12: Yes, our reconstruction includes information from France, the Morin temperature data from Paris during the Maunder Minimum (in Luterbacher et al. 2004, 2007 and Xoplaki et al. 2005) Please note, there is a GRL paper by Slonosky (2002) that report on the monthly precipitation series of Paris going back to the 17th century. A comparison with those data would also be of interest.

We mention the comparison with V. Slonosky report on precipitation now in the paper,

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as requested. As expected from Etien et al. (in press) there is no significant correlation between our reconstruction and the precipitation in Paris. Corrected version: In §4: "In Paris (France), some early instrumental data are available for temperatures (Legrand and Le Goff, 1992) or precipitation (Slonosky, 2002). However, these early instrumental data are probably affected by changing observation conditions and have not been homogenised. The precipitation, are not correlated with our data (R2=0.09, n=116, p=0.0009), what could be expected from the calibration study over the 20th century (Etien et al., in press)."

15. Page 1086 ff: I found those pages dealing with the correlation analysis with NH or European TT reconstructions quite difficult to follow. It is quite critical to compare local with large scale averaged European temperature or even NH estimates. I was a bit surprised about the comparison between yours and the Luterbacher et al. (2004) temperature reconstructions. A proper comparison would be to choose a couple of gridpoints from Luterbacher et al. (2004, 2007) and Xoplaki et al. (2005) around your area rather than the European mean. The comparison with the European mean does not make much physically sense. As we have monthly estimates from 1659 to 2002 to average those gridpoints over the Avril-September period rather than only the summer mean. As the data are available both in the monthly resolution and also for the area of interest, I do also not understand that you compare it with the JJA European mean which no surprise does not return high values. Chuine et al. (2004) did this in a similar analysis and found much higher correlations. Therefore I expect similar results with your new data.

We are thankful to J. Luterbacher for sending us the set of grid-points centred on Fontainebleau. In the new version of the paper, we have compared our reconstruction with the average gridpoints (monthly estimates over April-September). The correlation is quite good with a R2 about 0.5 all over the time period. See figures 5a and 5b and "Comparison with reconstructions based on proxies" in section 4.

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Interactive comment on Clim. Past Discuss., 3, 1063, 2007.