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Climate of the Past Discussions

Interactive comment on "The longest homogeneous series of grape harvest dates, Beaune 1354–2018, and its significance for the understanding of past and present climate" *by* Thomas Labbé et al.

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1 Summary

I would like to thanks the authors for letting me review their work. I found it a very interesting read and it is a very impressive dataset. The authors have carefully collected a complete annual history of the grape harvest dates in the Beaune region by collating various archival records all the way back to 1354 AD.

These grape harvest dates are thought to provide strong correlation with temperatures in the growing season (April-July) since the harvest date is linked to the ripeness of the grapes. The authors evidence this correlation through comparison with the Paris temperature series from 1659-2018 where good agreement is seen. This suggests that the Beaune record may be used to provide climate information extendinf further back in time to the 1300s.

The work is well written although it would benefit from some minor English grammar and spelling alterations.

2 Comments on work

I have four main comments/suggestions for the authors described below

2.1 Improved introduction and clarification of notation

As someone without any previous knowledge of grape harvesting in France it took me until a few pages in (and the first plot) to entirely understand what a GHD was. Initially I wondered if each individual vineyard might have a different harvest date and so you were recording many dates in a single year. For a non-expert, the paper perhaps presumes a little too much prior knowledge in this area in particular regarding the terminology.

Even after reading I was still a little confused as to some of the practical aspects of grape harvesting from the perspective of the physical harvester. How in general is a GHD decided upon? What are the factors that come into play? Presumably ripeness of grape but are there other factors such as weather forecast; national holiday; the weekend/weekday? Who decides on grape ripeness and how do they decide?

Is a GHD the data on which the town administration permit harvesting to begin, but an individual vineyard can harvest after this if they like (but not beforehand)? Or do all vineyards in the region have to harvest on the same date? What is a ban (and specifically a vintage ban)? is it that all vineyards are banned from harvesting before a certain date; if so how is this different from a GHD? All these terms were used in the paper without my full understanding.

It would be nice if the authors could include a short (imagine 1-2 paragraphs would be sufficient) description at the start to give a bit of a practical background to grape growing and harvesting in France; a description of a typical cyclical year in a vineyard; and a description of all the later terminology.

2.2 Consistency of determining the GHD

I am particularly impressed by the work that has obviously gone into collating the GHDs from different historical records; and in particular the clarity and honesty in describing the relative strengths/ weaknesses of the four approaches. Of the four approaches the one requiring the strongest assumptions is that based upon Church records (1507-1699). Here the authors have assumed that the GHD takes place 8 days after the church meetings to organise food provisions.

The accuracy of this delay is critical in determining the level/amount of harmonisation required for the series. If, it in fact took 15 days (i.e. an extra week) from the church meeting until the GHD then this would mean no harmonisation of the time series would be required (or at least not at 1700 but rather more likely much earlier).

The paper suggests there are some years for which ones has both the dates of church meetings; and either wage payment or city council records albeit potentially fragmentary. It would be good to see what the delay between church meetings and GHD was for these years when the GHD was known exactly to see if this delay is consistently 8

years; or if it is smaller/larger.

2.3 Harmonisation of time series

The issue which, in my mind, is likely to cause most discussion/disagreement amongst readers is the harmonisation of the time series whereby the raw GHDs from before 1718 are moved 7 days later in order to make the series as a whole agree with other GHD records. The authors do provide what appears to be a reasonable justification for this — a change in wine production and commercialisation. Without a specific administrative edict describing a decision to call the GHD in the region later as a consequence this does however slightly weaken the series as an entirely independent way to tell us about climate in the region — do we know for sure that there are not other similar changes at other times in history? However, the fact this is a uniform and constant shift does alleviate this concern to a large extent in my eyes.

This made me wonder somewhat as to whether the primary interest/power in the series was more to do with climate or rather to identify changes in vinoculture practices. Equally, the fact this change occurs at 1718 is presumably heavily reliant upon the assumption of an 8 day delay between church records and the GHD. If the delay were longer then the shift would be applied at a different cut-off (e.g. much earlier in time).

2.4 Statistical modelling

As a statistician, I found the details of the modelling section 3.2 a little hard to follow in terms of exactly what models were fitted. It would seem from the description that two model approaches were used — a frequentist approach in model A; and potentially a Bayesian model B using CCC400. If this is correct then I suggest below a way the authors might wish to describe the models more clearly (and in more formal statistical language) so they could be easily reproduced/understood by others:

2.4.1 Frequentist Approach — Model A

Here I was confused with where the transformation of the variables occurred. As sometime the authors introduced a T' and D' but then their models as described include neither of these terms. Can they just write down the model in terms of the notation they define earlier? Is the model for example

$$T' = 36.5 - 0.080D'$$

where

$$T' = \frac{1}{1 + \exp\left(\frac{-(T-18)}{3}\right)}$$
$$\text{and} \quad D' = log(D - 150)?$$

Also, is $\log$ natural log or base 10?

2.4.2 Bayesian Approach — Model B

If you wanted to frame model B as being a Bayesian method then this could be done as follows. The CC400 simulations provide a prior on x_j (the April-July mean temperature). This prior is in terms of equally-likely sample values $(x_{m,i})_{i=1}^{7}440$, each of which is accompanied by a modelled $y_{m,i}$ (the corresponding GHD for $x_{m,i}$). We wish to find a posterior estimate for the April-July mean temperature in light of the true GHD z_j by reweighting the prior according to Bayes theorem:

$$P(X_j = x_j|z_j) \propto f(z_j|x_j)P(X_j = x_j)$$

where $f(z_j|x_j)$ is the conditional density of z_j given x_j i.e. $w_{i,j} = f(z_j|x_j) \sim N(z_j; x_j, r_{EKF}^2)$, the density of a normal with mean x_j and variance r_{EKF}^2. Our re-

constructed temperature is then the posterior mean of $X_j|Z_j = z_j$:

$$E[X_j|Z_j = z_j] = \frac{\sum_i w_{i,j}x_{m,i}}{\sum_i w_{i,j}}.$$

2.5 Possible suggestions the authors might wish to consider for future work?

- While not expected in this paper, one might wish to formalise the identification in changes to the time series using changepoint methods. This could identify both changes in climate but also potentially vinoculture practices (in light of the observed change in grapes around 1718). For example is there a point at which irrigation became more common/advanced that affected the GHD? There are some off-the-shelf (and hopefully fairly easy to apply) statistical packages which might provide insight that visually is harder to see.

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