

egusphere-2022-1451

Viticulture extension in response to global climate change drivers – lessons from the past and future projections

Replies to comments of Reviewer #1

I also found the study technically rather convoluted, and I am left wondering if, at least the part of the study referred to future conditions, could not have been more easily conducted by just directly analysing the output of global (and regional) climate simulations and applying, for instance, the VI index to those data. I guess the reader would scratch their head wondering why an emulator and an indirect estimation of the impact of external drivers is needed in the first place.

It is true that, if the only objective was the future viticulture, it should be more straightforward to calculate VI on the model simulations, and that the emulator was not necessary. But we want also to produce such analysis for any period of the past and to compare the future to the past. The emulator was build for that. Viticulture is one example of application – and it is important for stakeholders – and we have tried to show that it is easy to extend the analysis to other examples. Another objective was also to show that our approach is also a good attribution method. We will try to make that clearer.

1) I think that the justification of the methodology will not be clear for many readers. The method is rather convoluted, involving an ensemble of simulations with Earth System Models, a statistical downscaling model, a combination of model output and proxy-based reconstructions using a Bayesian framework. Is this complex methodology necessary at all ? why not just take the output (e.g. median) of the ensemble of climate models ? Is the data assimilation needed to somehow correct the possible errors of climate models ?

Concerning the necessity to make these complicated developments, I think that they are necessary to provide a tool which runs fast at the end. We see that the justification is not clear enough, so we will improve it in the second version.

2) Some methodological steps are too shortly explained. The climate reconstructions used in the data assimilation step appear almost out of the blue. They should be included in the material and methods section. Perhaps also the data assimilation methodology should be explained here as well.

Well noted, we will try to improve the explanations

3) Section 3.3 (independent validation) raises some questions that the text simply glosses over. The text asserts that the agreement between the independently reconstructed PSDI and the model output is good, but Figure 9 does not convey this impression. The assessment is essentially visual, comparing the panels in Figure 9, but the colour coding used does not really help the reader to see the similarities and differences. Admittedly, colour bars are rather subjective, and in my experience some readers find some useful when other readers find them difficult. Here, however, it is difficult to distinguish the colour tones. E/EP for 1300, for examples, is just blue everywhere. Would it be possible to use, say, 10 hues that the eye can easily separate ? To me, the panels for 1300 BP look very different, also the agreement shown in the panels for 1000 BP and 700 BP is questionable. I believe the authors that the data sets may agree, but the pictorial representation is really not adequate to convince the reader.

Thank you for this remark which is very important. As we told in the text, it is difficult to calculate quantitative statistics. We will try to modify the color codes as explained by the reviewer.

6) 'Note that this value underestimates the true earth surface temperature because our mean is based on the equirectangular projection which gives too much weight to the high latitudes.'

What we have done is to calculate a raw mean based on the gridpoints available. We agree that it should be more rigorous to calculate a weighted mean taking into account the area of the gridpoint.

The bias coming from our rough method has no effect on our results for two reasons: (1) we work on the anomalies and (2) we work on the Mediterranean region much far from the northern region. Instead to present biased raw values, a solution could be to present directly anomalies.

7) 'The sunshine percentages are obtained by linear regression on temperature and precipitation (Guiot et al., 2000)' Models produce downwelling solar radiation at the surface. So why use an indirect approach ?

We wanted to limit at maximum the number of variables to be estimated by the emulator. So we have emulated temperature and precipitation and deduced sunshine from them, as we have done before in Guiot et al 2000 and following papers. Sunshine has a limited effect on the vegetation simulated by the Biome model.

8) .... Were these time series normalized prior to PCA?

Yes they are.

9) 'This process is known as a data-model assimilation ....

We agree that this paragraph must be written more clearly. The objective of the data assimilation is to make converge the simulations towards the paleo data by adjusting the effect of volcanic and solar activities and so understand what forcing is the most important to explain the climate variations of the past periods studied. It is then intended to improve understanding of the forcing effects and not only to improve the predictions.

10) 'anomalies from the pre-industrial period for the 10 spatial boxes and the 9 time slices, obtained from pollen (Guiot and Kaniewski, 2015) and corrected/precised as indicated in Table 1 of the main text.'

Sorry it is a mistake, correct table is Table 3

11) 'the sum of the product of monthly temperature and precipitation for the growing season (Hyl),'  
The sum or the product ?

To make clearer: the sum on the growing season of the monthly temperature multiplied by monthly precipitation

12) units are missing

This will be corrected

13) ... Do they also include the effect of CO<sub>2</sub> on water efficiency ?

Yes it is true; it will be precised.

14) ... The VI is validated by just comparing with the present climatology. It is a new index and apparently, there is no other type of validation. How can we be sure that this index can describe changes in potential viticulture well ?

This index is closely based on previous indices taken from the literature and it is validated visually by comparing to the present viticulture extension. This seems to me sufficient for the objective of this paper.

15) ' Fig.6 presents the overall correlations between the emulator outputs and the proxy-based reconstructions.' The x-data and the y-data are in my understanding not totally independent. The emulator has used the reconstructions in the data assimilation step, so it is not totally surprising that they are correlated . Also the caption is not clear, specially this sentence: Temperature dots correspond to the 10 boxes of the 11 periods between 2500 to present and precipitation data to the two oldest periods (4200 and 3200 yr BP) and the present.' Does it mean ' Temperature dots represent the mean temperature in the 10 boxes in the 11 periods between 2500 BP until present and precipitation dots represent the mean precipitation in the two oldest periods (4200 and 3200 yr BP) and in the present,

Thank you for helping to improve the caption. It is true x and y should be ideally correlated with a  $R=1$  (blue line), but as in standard regression approaches, this is only reached if the data assimilation is successful. Ideally all the dots should be distributed along the blue line. It is true that this verification is not independent, it is why an independent verification is done in Fig.9.