

Strandberg et al.: “Regional climate model simulations for Europe at 6k and 0.2k years BP: sensitivity to changes in anthropogenic deforestation”. *Clim. Past Discuss.*, 9, 5785-5836, 2013.

## Response to Reviewer #1

The authors would like to thank the reviewer for making the effort to read our manuscript and provide good constructive suggestions, and for appreciation of our work. We generally accept all comments made by the reviewer, with a few exceptions. Answers to all comments follow below.

### SPECIFIC COMMENTS

1. One conclusion in abstract is that deforestation leads to higher temperatures because evapotranspiration is lower in unforested areas. But this ignores the effect of irrigation in agricultural areas, which would increase moisture supply and possibly increase evapotranspiration, thereby lowering summer temperatures. Presumably this irrigation effect isn't represented in RCA or LPJ-Guess. This irrigation effect might be particularly important in southern Europe.

Large-scale areas of irrigated agriculture was limited to very small areas in preindustrial time with the exception of the Nile valley and delta and Mesopotamia, both of which are not present except on the very margins of our study area. Other parts of Europe that are extensively irrigated at present, e.g., the Ebro basin and the rice fields of the western Po valley, were not largely developed for irrigation until the early 20<sup>th</sup> Century AD.

2. How is ‘present’ defined? (see page 5789, line 22). Is it 1950AD radiocarbon? Clarify whether 0.2ka is 1750AD.

0.2ka is 1750. This information is added in the RCA3 description: : “All RCA3 simulations have been run for 50 yr with 1-yr spin-up time (simulated years are 3909-3861 BC for 6k and AD 1701-1750 for 0.2k), ...” See also comment #5.

3. P5791,L14: What does it mean for the iterative modeling to be a ‘viable modeling approach’? I'm generally prepared to accept that this is a valid approach, but would like to know more about these prior papers and how they assessed the viability of this approach.

Some explanations are added in the text and “viable” is changed to “reasonable”: “... has been shown to be a reasonable approach where both simulated climate and vegetation are in general agreement with available reconstructions, which are few and uncertain (Kjellström et al., 2010; Strandberg et al., 2011).”

4. ECHO-G Oetzi2 run. How was the model initialized and spun up?

Explanations are added in the text: “... 2.8° × 2.8° and 20 levels in the oceans. The simulation was initialised at the end of a 500 year spin-down control (quasi-equilibrium) run with constant forcing (orbital, solar and greenhouse gas) for 7 ka BP.”

5. Specify the 50-year time windows from the Oetzi2 run used to drive the RCA3 simulations. This is particularly important to know for the 0.2k BP run.

This information is now added in the text: “All RCA3 simulations have been run for 50 yr with 1-yr spin-up time (simulated years are 3909-3861 BC for 6k and AD 1701-1750 for 0.2k), ...”

6. P5795, L19: How was this upscaling done? Simple averaging?

Yes, the sentence is changed to: "The upscaled (averaged to a 0.5° resolution) versions of both datasets are used for the two selected time windows."

7. The exploration of data-model and data-data discrepancies in the paleoclimatic simulations is quite thorough and well done. However, it is a bit hard to follow and lacks accompanying figures showing the paleoclimatic proxy reconstructions. Only the pollen-based paleoclimatic reconstructions (which are at greatest risk of circularity) are shown.

This is a problem, but unfortunately the proxy reconstructions are a mixture of qualitative and quantitative data representing single months or entire seasons; some give values others give intervals. Therefore it would be difficult to include them in e.g. fig 5. One option could be to collect the data in a table, but that table would not provide more information than reference, type of proxy and estimated values which are already given in the text. (See also comment #13.)

8. When discussing the possible reasons for mismatches between the climate simulations and pollen-based reconstructions (P5803-5806), another possible issue is the challenge of accurately disentangling multiple climatic variables from the fossil pollen data.

Yes, we acknowledge this in a new sentence: "... which may explain that the patterns around 6k are difficult to capture both by the climate model and the PB reconstructions. Also, there is a general problem of accurately disentangling multiple climatic variables from the fossil pollen data which causes uncertainties in the PB reconstruction. Further, there is no equivalent ..."

9. P5807 L26: Why say that there are 'no systematic differences between the models'? Figure 9 strongly suggests systematic differences.

Fig. 9 shows differences in albedo and latent heat flux, does the reviewer mean Fig. 11?

By systematic differences we mean that there is no model in which the temperature or precipitation difference is always larger/smaller than the other models for all seasons or regions. A few sentences are rewritten to make this clearer: "The choice of another GCM would obviously provide different results, but the difference is difficult to quantify. It is not obvious that the choice of another GCM would lead to generally larger or smaller temperature and precipitation differences. Furthermore, RCA3 partly produces its "own" climate."

10. P5809: Agreed that the Kaplan (K) land-cover reconstruction at 0.2ka is in better overall agreement with the LANDCLIM reconstructions (versus the LPJ and Hyde vegetation reconstructions). However, Figure 12 clearly indicates that the K reconstructions are overestimating the extent of agricultural deforestation, especially in Central Europe. The authors acknowledge this point at the top of p5810 but downplay it. I suggest deleting 'slightly' from the top of page 5010 and adding a sentence noting that the true extent of agricultural deforestation at 0.2ka probably lies between the Hyde and Kaplan estimates, but probably closer to Kaplan.

This section is rewritten and merged into section 2.1.4. The comparison between REVEALS, Hyde and Kaplan is made more general since it isn't the main focus of the paper.

11. Suggest deleting lines 5-13 on p5180. This treatment of land cover effects on future climate simulations is pretty cursory and not essential to the paper. Recommend keeping the commentary on past climate changes.

The lines are removed: "~~Previous high resolution climate simulations of the 21st century performed with the objective to assess the effects of vegetation changes on future regional climate in Europe indicate that the feedback effects of vegetation change on climate are a mixture of the albedo effect and other effects from changes in land surface properties (e.g. Götzel et al., 2008; Wramneby et al., 2010). The change in forest fraction during the 20<sup>th</sup>-40~~

century is small ( $\pm 10\%$ ) compared to the difference between the alternative land cover estimates used in this study, which makes the vegetation contribution to climate change much smaller than the contribution from increasing amounts of greenhouse gases in the 20th century. For past climate, studies conducted ...”

12. Suggest adding a sentence to the conclusions stating that the pollen-based vegetation reconstructions are most similar to those of Kaplan (vs. Hyde and LPJ) but suggest that LPJ may be inadequately representing heathlands in northern Europe and that Kaplan may be overestimating agricultural use in eastern Europe.

The comparison REVEALS, Hyde, Kaplan is removed from the conclusions. The comparison is only on a general level and not a result of this study. See also comment #10.

13. Suggest adding the proxy-based paleoclimatic estimates to Fig. 9.

\* Fig. 9 shows differences in albedo and latent heat flux, does the reviewer mean figures 5 and 8? Unfortunately the proxy reconstructions are a mixture of qualitative and quantitative data representing specific months or entire seasons. Therefore it would be difficult to include them in e.g. fig 5. As an example Fig. 5 show simulated temperature difference for summer (JJA). The proxies on the other hand represent either JJA or just July. The values are given as specific numbers, as intervals or as a quantitative statement (e.g. colder/warmer). See also comment #7.

14. It'd be helpful to see a map of the REVEALS land cover reconstructions (currently, only differences from simulated vegetation are shown).

Fig. 12 is changed to show the actual land cover reconstructions and not differences, since the comparison is downplayed, see also comments #10 and #12.

## TECHNICAL CORRECTIONS

Suggest replacing run name '6kV+H' with '6kVH' (and same change for '6kV+K') to make it easier to read – e.g. '6k\_V+H-6kV' in Fig. 3 legend is quite hard to parse

The “\_” is removed but the “+” remains. We want to make it clear that the H and V estimates are added to the LPJ-GUESS vegetation, they are not totally separate. In figures like Fig. 3 parentheses are added to hopefully make the reading easier, e.g. (6kV+H) – (6kV). At the same time we are forced to change K to KK10 to distinguish KK10 from e.g. KK11, KK12, KK14.

P5787

L15: “simulated deforestation is much more extensive than previously assumed, in particular according to the KK model” – this isn't quite right because prior published work by KK has already argued for extensive deforestation. Suggest instead to merge this sentence with next one “At 0.2k BP, extensive deforestation, particularly according to the KK model, leads to significant temperature differences :::”

The sentence is changed to: “At ~ 0.2 kBP, extensive deforestation, particularly according to the KK model, leads to significant temperature differences in large parts of Europe in both winter and summer. In winter, deforestation ...”

L20: since->because

Ok

L21-22: Clarify that this conclusion about deforestation causing drops in temperature is specific to Southern Europe.

The sentence is changed to: “Accordingly, the albedo effect dominates in southern Europe also in summer, which implies that deforestation causes a decrease in temperatures.”

P5788

L1: replace ‘a thorough comparison with’ with ‘definitive discrimination among’

Ok

P5789

L7: insert ‘on climate’ after ‘direct effect’

Ok

P5790

L10: LANDLIM -> LANDCLIM?

Ok

L11: insert ‘of pollen dispersal’ after ‘mechanistic model’

Ok

P5791

L5: use->uses

Ok

L22: replace ‘so called’ with ‘transient’

Ok

P5795

L10: replace ‘significantly’ with ‘substantially’ (significance usually implies a formal test for statistical significance)

Ok

P5808

L13: replace ‘covers’ with ‘cover’

Ok

Table 2: rows in ‘MAT PFT’ are misaligned with other columns. For example, no MAT PFT equivalent is listed for Abies nor Pinus.

This will be fixed in the typesetting.

Fig 5 legend: ‘is different for’ -> ‘differs from’

Ok

Fig 8 legend: 'is different for' -> 'differs from'

Ok

Fig 9: Suggest reversing the color scheme for the albedo difference plots (left column) so that strong positive anomalies are colored blue instead of red. A higher albedo will tend to result in lower temperatures, so a blue color scaling would more intuitively match this effect.

Ok

Fig 11 legend correct typos 'a nd' and 'GCM:s'

Ok