

## Response to Reviewer #2

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.

This is an interesting study that addresses the question of how much anthropogenic land-cover change feeds back to regional climate using a regional climate model to conduct sensitivity tests, with land-cover estimates informed by theoretical and empirical land-cover data. The study is elegantly designed and presents some intriguing results. There are very few problems with the study, but I do wonder about the wisdom of including the last experiment/comparison, as I fear it is not given enough attention and is about rather a different point than the rest of the work, which is a sensitivity experiment.

Comparisons of proxy-climate reconstructions with simulated climate, which form the final element of this paper, led to mixed success, with both variation in GCM input and uncertainty in proxy reconstructions raised as possible explanations. This is not surprising, but I wonder about the logic behind the approach to the climate comparison and indeed whether it needs to be in this paper at all. The model simulations reflect global forcing and also local grid-scale dynamics such as surface energy, and they are likely to be sensitive to land-cover variation. The fossil reconstructions, purposefully chosen to not reflect vegetation, largely use proxies reflecting summer temperature (lake organisms, tree rings). In the case of lake organisms, there is also uncertainty associated with the transfer function method itself. Neither of these proxies is sensitive to change in land cover, so the reconstructions would be expected not to agree with any simulation that is sensitive to deforestation. Reconstructions based on pollen values, even with PFTs, assume the signal is that of potential natural vegetation, which is detectable even in considerably transformed landscapes (otherwise the bioclimatic link underpinning the reconstruction breaks down). Thus I am not surprised that the reconstructions are different. It seems to me that this mismatch is quite important. It may be that where human impact on land cover is important that there is a serious likelihood that most proxy-based reconstructions will deviate from simulated data (and more importantly, the actual historical values). I would suggest that more could be made of this in both the rationale for the experiments, the explanation of what the different proxy datasets can and cannot do, and the explanation of the results. If this makes the paper too unwieldy, as I suspect it would, you might think about making this part a different paper. It might be less confusing, as I think at the moment this part a somewhat incompletely investigated add-on to the really elegant sensitivity tests.

That Northern Britain does not fit anything is no surprise at all. This region has been almost 100% deforested and is maintained via human action in a state would be an azonal vegetation type under less disturbed conditions and which, therefore, has little in the way of a useful climate signal. I think you say this, and it is worth emphasizing, as the weirdness of British vegetation is quite likely not universally understood!

The sensitivity studies are the main focus of this paper. However, we think it is not enough to just present results from one model simulation, the results have to be put into perspective. We are doing this in mainly two ways: (i) by comparison with other model simulations and (ii) by comparison with proxy data/reconstructions. (i) shows that our results are not totally different from other model simulations and (ii) shows how our results relate to other estimations of the climate. Nevertheless, these comparisons were rather included as supporting information than a separate study topic. We are aware of the problems of using the pollen-based reconstructions, and this was extensively discussed within the group of authors. We chose to include it because it is the only spatially explicit description of past climate existing to date (see also comment below). We agree that it is something which needs lots more discussion room and could be a

possible topic for a new article, but not possible to discuss fully within the scope of the present one. The bottom line is that we can't omit the model-model or model-data comparisons since they give necessary perspective to our results, at the same time the comparisons are not the main scope of the study and the text would be too extensive if these comparisons were enlarged.

#### Minor comments linked to page/line numbers

5789/2 change sentence around – awkward. Since we expect vegetation change to affect climate at the local/regional spatial scale, a high spatial resolution in the climate model is critical. When evaluating model results by comparison with observations and/or proxies that represent local to regional environment conditions. [need to know how used data re 6000 yr BP 5789/21]

The sentence is changed as suggested.

5790/20 – clarify for the reader where the circular reasoning is potentially coming from in this exercise. Presumably RCA is informed by the landcover that you also use to reconstruct past climate?

A clarification is added to the sentence: "... Nielsen et al., 2013) to avoid any circular reasoning (where the same vegetation would be used both to force and evaluate the model simulations), and (ii) ..."

5793/1 - change, not changes

Ok

5793/6 - curious that all forest + snow albedo is the same, as there could be a considerable difference between deciduous and coniferous cover with snow?

In reality, yes; but in the model, this is the approximation that is done. Given all the uncertainties connected with radiation in the forest implementing a prognostic forest snow albedo was considered not to be worth the effort.

5796/8 - clarify the spatial nature of the K, H and LANDCLIM treatments – is the rescaling per grid cell and thus homogeneous across the model domain?

Yes, the rescaling was done per gridcell and is homogenous across the domain and all the different LU scenarios. Some clarifications are added in the text. "... and thereafter homogeneously rescaling the PFT values provided by V in all grid cells to fit into the remaining space."

5797/13...based on a multi-method approach... (not previously mentioned) and – the paragraph is slightly unclear about the role of pollen-based reconstructions. You take care to remove the pollen from the LANDCLIM climate proxy dataset but then you use two pollen-based reconstructions as comparators in part of the region. This needs a bit more explanation for the reader. It may not be the same dataset, but it is still a pollen dataset. See also commentary above.

1. "...based on a multi-method approach... (not previously mentioned)".

We don't see any reason to mention this earlier in the paper. This is the section on the climate proxy data we are using and there is nothing said about this earlier in the text.

2. "the paragraph is slightly unclear about the role of pollen-based reconstructions. You take care to remove the pollen from the LANDCLIM climate proxy dataset but then you use two

pollen-based reconstructions as comparators in part of the region. This needs a bit more explanation for the reader. It may not be the same dataset, but it is still a pollen dataset. See also commentary above".

We thought it was clear from our text why we use the pollen-based reconstructions "anyway". But since it seems not to be clear we add two sentences after " the LANDCLIM database of past climate proxy records, consisting mainly of site specific/point reconstructions of past climate based on non-pollen proxies; and the spatially explicit pollen-based climate reconstruction of Mauri et al. (2013).", 5797/6:

"The LANDCLIM project itself is concerned about circular reasoning and avoids using climate reconstructions based on pollen records because the REVEALS reconstructions of vegetation cover are also based on pollen records (see below). Nevertheless, in this study, we chose to also use a pollen-based reconstruction of climate for Europe because it is the only spatially explicit description of past climate existing to date, however keeping in mind that the pollen data used might bias the climate reconstruction due to significant human-induced changes in vegetation from ca. 3k (e.g. Gaillard, 2013) (see discussion)."

5811/3 ..understanding of past land...

Ok

Table 2 – the caption reads "the three PFTs". Do you mean "the three LCUs"?

No. But the header should read "RCA PFT". This is corrected.