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Interactive comment on "Development and testing of scenarios for implementing Holocene LULC in Earth System Model Experiments" *by* Sandy P. Harrison et al.

Anonymous Referee #2

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Review of Harrison et al., gmd-2019-125 Development and testing of scenarios for implementing Holocene LULC in Earth System Model Experiments

This paper describes a protocol for implementing LULC data in model simulations of Holocene climate as well as ways to create and test input to the LULC reconstructions and to test the output from the climate models. This is a welcome effort. LULC is a known climate driver that still is often not included in climate simulations. Proper data sets and protocol could hopefully make LULC a little bit easier to include in simulations in the future. Such a welcome effort will of course merit publication.

The paper describes a wide range of methods for a wide range of research areas. This

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makes it a bit difficult for someone, like me, that is familiar with perhaps one or two of these research areas. I apologize already for the comments that I will raise that emanates from my ignorance in for example archaeology. But, this paper will be read by people that are not experts in everything that this paper covers; thus take my comments, although ignorant, as a motivation for rephrasing the text to be understandable for the non-expert.

The paper could use some rearrangements and clarifications before being published, otherwise the methods are sound and relevant. There are also some uncertainties about how all this will be done in practice. Comments follow below.

How are these LULC reconstructions better/different than HYDE and KK10? Are the methods different? Do we know that it is better? This may be obvious for everyone in the LULC business, but it is not explicitly explained in the text, at least not as far as I can see.

Is it possible to do uncertainty ranges? Some regions will inevitably be more uncertain than others. When you do a global map you tend to think that the uncertainties are the same everywhere. How do you deal with that? Also, the paper kind of assumes that data availability is as good as for the northern hemisphere in all of the world. I guess a lot of your methods won't work that well in parts of the world. How do you deal with that?

I think Section 2 is a bit confusing to follow. What is it that you want to show? Is it only to give a hint of the outline of the paper? That could be done much simpler. Section 1 introduces about the same concepts in a nice way, and the rest of the paper gives the details. It's hard to know if this is a description of the paper or something more general about the LandCover6k methodology (if these two are the same, please say so). I think that the rest of the paper will be easier to read if Section 2 clearly lists the three main points: 1) ways to improve data 2) ways to test data 3) the protocol. If this structure is kept and clear for the rest of the paper it will be easier to follow. Because it's mixture of

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methods and results that is not always so easy to follow.

In Section 5 I don't get if REVEALS is used as an input to the LULC reconstructions or if it is used to evaluate the reconstruction. Is it only the fraction of open land that is evaluated? How is land cover reconstructed without REVEALS as the archaeological data (as I understand it) only give fraction of open land/land use.

For Section 6 I have a few concerns. First, should results be a part of a protocol paper? If it should, why are the results buried in the caption of Fig. 8? Are they old or new results? Make a proper paragraph explaining the results.

Second, the studies of LULC effects on simulated paleo climate that I'm familiar with tell clearly that despite radical changes in land cover the, although significant, differences in simulated climate are small compared to the uncertainty range in the proxies. It is not possible to assess which land-cover description is the most reasonable on the basis of a comparison of modelled climate with paleo climate reconstructions. (e.g. Strandberg et al., 2011; Strandberg et al., 2014). Your own results show this also. How do you plan to overcome this?

* Minor comments

L53: IPCC SRLUCC says 70% did you do a different kind of estimate? If you did, please explain why it's different.

L61: I don't think it's good to have the abbreviation LULC after the sentence "...as a result of land use". I guess LULC means land use and land cover. Spell out LULC before "affects the carbon cycle" on line 64 instead.

L95: "differences in the underlying assumptions" It would be interesting to know about what these assumptions are.

L175. "LULC scenarios" Is "scenarios" the right word here? I would go for "reconstruction" as "scenario" for me means an assumption about the future, with emphasis on the word assumption. These "LULC scenarios" are not based on assumptions but "a

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number of products", i.e. they are in some way based on facts.

L229. "expert knowledge". How is "expert knowledge" done, is it even a method? Please explain and/or rephrase.

L281-295. Here, references to the different panels in Fig. 6 would be helpful.

L328-329. How is this done globally, is it possible to do on a global scale?

L332. "transient" and "500 years". Is it correct to call something with 500 year resolution transient? Or should it rather be time slices. Compare the use of "transient" in Section 8.

L405. "contributions to the land C inventory can be specified..." Is this possible to achieve? Your assumption builds on that.

L542-545. This is not possible without first improving proxy data.

Fig. 3 The text is far too small. No explanation for the grey shading or the white dots is given.

Fig. 4 Two boxes in Level 1 don't connect to Level 2. I can see that "No human land use" doesn't have to connect to Level 2, but is it then necessary to include it in the figure? I don't see how "Extensive/Minimal land use" fits in the picture.

Fig. 5 Too small legends.

Fig. 6 I don't understand the coupling between "LandCover 6k working group" and "HYDE 3.x". What does "→" mean? I don't understand many of the panels. What are the axes? What are the squares? What is the grey shading?

Fig. 7 Far too small legends.

Fig. 9 I don't understand this, but it seems to be more complicated than it sounds, but the surrounding text doesn't give much help.

Table 1 What does "Modern" mean here? If it is pre-industrial say so. If it is modern (=

20th century) explain why you don't use pre-industrial.

* References

Strandberg, G., Brandefelt, J., Kjellström, E. and Smith, B. 2011: High-resolution regional simulation of last glacial maximum climate over Europe. Tellus 63A, 107-125. DOI: 10.1111/j.1600-0870.2010.00485.x

Strandberg, G., Kjellström, E., Poska, A., Wagner, S., Gaillard, M.-J., Trondman, A.-K., Mauri, A., Davis, B. A. S., Kaplan, J. O., Birks, H. J. B., Bjune, A. E., Fyfe, R., Giesecke, T., Kalnina, L., Kangur, M., van der Knaap, W. O., Kokfelt, U., Kuneš, P., Latalowa, M., Marquer, L., Mazier, F., Nielsen, A. B., Smith, B., Seppä, H., and Sugita, S.: Regional climate model simulations for Europe at 6 and 0.2 k BP: sensitivity to changes in anthropogenic deforestation, Clim. Past, 10, 661-680, doi:10.5194/cp-10-661-2014, 2014.

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