

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

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The referee comments that it is difficult to judge the manuscript because it is a proposal for work to be done, although they recognise that the approach outlined is novel in several regards and would make a substantial contribution towards providing higher fidelity estimates of past LULC. We recognise that the paper is a somewhat unusual protocol in that it combines the development and testing of input data sets for model simulations as well as the description of the proposed simulations themselves. We have chosen to do this because we feel it is important that the palaeoclimate modellers who will be running these simulations understand the strengths and weaknesses of the input

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data sets that are being developed. However, the ultimate goal here is to provide the protocol for simulations to be run by the PMIP group, building on the Holocene simulations that are already underway as part of CMIP6. The creation of the archaeological data sets and their use to improve LULC scenarios is currently being carried out by the PAGES LandCover6k working group, and it is anticipated that these data sets will be available for the PMIP community to use in 2020 – hence the need for a protocol to describe the planned experiments.

We can perhaps make the situation clearer by revising the introductory text to make it clear that work on the production of the input data sets is ongoing. (We will also be clarifying the status of individual components of the work in response to comments by Arneeth and Kjellstrom). Specifically, we propose revising the final paragraph of the introduction to read:

The Past Global Changes (PAGES, <http://www.pastglobalchanges.org/>) LandCover6k Working Group (<http://pastglobalchanges.org/landcover6k>) is currently working to develop a rigorous and robust approach to provide data and data products that can be used to inform reconstructions of LULC (Gaillard et al., 2018). LULC changes are taken into account in simulations currently being made in the current phase of the Coupled Model Intercomparison Project (CMIP6) for the historic period and the future scenario runs (Eyring et al., 2016). They are also included in simulations of the past millennium (Jungclaus et al., 2017), in order to ensure that these runs mesh seamlessly with the historic simulations. However, the Land Use Harmonisation data set (LUH2: Hurtt et al., 2017) only extend back to 850 CE and thus LULC changes are currently not included in the CMIP6 palaeoclimate simulations, including mid-Holocene simulations, that are used as a test of how well state-of-the-art climate models reproduce large climate changes. In this paper, we discuss how archaeological data will be used to improve global LULC reconstructions for the Holocene. Given that there are large uncertainties associated with the primary data and further uncertainties may be introduced when this information is used to modify existing LULC scenarios, we

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outline a series of tests that will be used to evaluate whether the revised scenarios are consistent with the changes implied by independent pollen-based reconstructions of land cover and whether they produce more realistic estimates of both carbon cycle and climate change. Finally, we present a protocol for implementing LULC in Earth System Model simulations to be carried out in the current phase of the Palaeoclimate Modelling Intercomparison Project (PMIP: Otto-Bleisner et al., 2017; Kageyama et al., 2018). However, the data sets and protocol will also be useful in later phases of other CMIP projects, including the Land Use Model Intercomparison Project (LUMIP) and the Land Surface, Snow and Soil Moisture Model Intercomparison Project (LS3MIP) (Lawrence et al., 2016; van den Hurk et al., 2016).

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