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Climate of the Past Discussions



# *Interactive comment on* "Reconstructing glacier-based climates of LGM Europe and Russia – Part 1: Numerical modelling and validation methods" *by* R. Allen et al.

**R. Allen et al.**

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I would like to thank the anonymous referees for their comments and support for the idea and rationale for attempting the work presented in this paper and the accompanying sister papers in the trilogy.

A common theme to both reviews is that the paper is a lack of clarity in the inference flow of the presented idea and methodology. The aim of this paper was to test a modelling approach, designed to reconstruct LGM palaeoclimates from LGM dated glaciers reconstructed from glacial-geological evidence, against the current cryosphere of Europe. This required two components: first, a glacier-climate model and second, a modern climate baseline. The reasons for using a degree day model are discussed in

Section 2.3 of the paper and are not repeated here. As mentioned by Reviewer 1 there are alternative and more complex methods available for reconstructing datasets representing present day climate; however, we feel that the CRU2.0 climate dataset (New et al., 2002) represents the best currently available observation based dataset with the required spatial coverage. The series of experiments presented in the paper were designed to show that the DDM and CRU2.0 climate dataset coupled using the downscaling procedure described in the paper could simulate the present day cryosphere of Europe; therefore, providing confidence in the palaeoclimate reconstructions and comparison analyses presented in the remainder of the trilogy. Individual sentences identified by both reviewers as contributing to the lack of clarity will be revised and the suggestion made by reviewer 1 for a diagram describing the inference flow of the paper will be included in the final manuscript.

The remainder of this comments article is spent discussing specific comments made by the reviewers; written in italic text.

**Reviewer 1**

*The rationale behind the form of the cost function is not established*

A cost function used in this paper is a simple tool to compare any two spatial patterns (in this case model output with World Glacier Inventory observations over the same area) and produces a unitless value indicating how similar they are; a value of zero indicates no agreement and a value of one a perfect match. There is no deeper or more complex statistical rationale that can be included.

*The second problem with the paper is that the output compared to present day observations depends directly on the CRU dataset*

The reviewer is correct to state that the model output is dependent on the CRU data; however, we do not view it as a problem. The simulations presented in this paper were designed to test if the model driven by the CRU data could reliably recreate the



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present day cryosphere of Europe in all its current and varied locations (e.g. maritime Scandinavia or the more continental Alps), and provide a suitable baseline from which to attempt palaeoclimate reconstructions (see below).

*If you need CRU data to reconstruct climate what will you need do to at the LGM?*

Palaeoclimate reconstructions are often presented as anomalies (e.g. present day 8211; LGM); therefore, a starting 8216;baseline8217; describing present day climate is required (e.g. 0k GCM simulations or pollen plant functional type calibrations with modern pollen assemblages). This work was a first attempt to produce continental scale palaeoclimate reconstructions from mountain glacial-geological evidence; this paper demonstrates that the CRU data are an appropriate 8216;baseline8217; from which to derive palaeoclimate estimates in the first instance. As better datasets are developed the alternative methods outlined by the reviewer for creating climate data should be used to refine the techniques outlined in the paper.

**Reviewer 2**

The reviewer makes several references to *reconstructed PDD*

The model does not explicitly reconstruct PDD; it uses fixed values for snow and ice derived from published values measured during the 20th Century (Page 1137, Line 20). Incorporating variable PDD would represent an interesting evolution of the outlined modelling approach and is the basis for potential new work; however, it is beyond the scope of this paper.

*The reviewer raised a series of specific questions relating to details of the model.*

*1. Importance of isostatic effects is raised by the reviewer.*

Isostatic effects were not explicitly considered by the model. By considering only mountain glaciers it was felt that the omission of this factor would not materially affect the results.



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*2. The use of uniform precipitation rates across each month*

The CRU data is monthly; the model is run on an hourly timestep and then scaled up to the monthly timestep, therefore the precipitation had to be downscaled. Owing to the inherent simplicitly of the model there was nothing to be gained by applying the precipitation data more 8216;realistically8217; e.g. as rain events.

*3. Minimum temperature occurs at 3 am*

The minimum temperature of a diurnal cycle usually occurs between midnight and dawn, so 3 am is not unreasonable. Furthermore, the model has no solar component, therefore this equation has no impact on the model result.

*4. It would be interesting to know the number of tests on different combinations of temperature and precipitation lapse rates plotted in Figure 3*

189 (Page 1140, line 17)

*Model adjustments, here the authors should clearly state that they adjust their model for all regions at once I realised this much later in the text (and I hope I correctly understood this crucial aspect of the method)*

No adjustments to the model (in terms of model parameters or input data) were made during the simulations. Each region was modelled independently; 189 different simulations were run for each region to assess the effect of the different lapse rate combinations (used to downscale the CRU data to the DEM) outlined on page 1140 had on the regional predictions made by the model.

References

New, M., Lister, D., Hulme, M. and Makin, I.: A high-resolution data set of surface climate over global land areas. Climate Res., 21, 1-25, 2002.

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Interactive comment on Clim. Past Discuss., 3, 1133, 2007.