

Interactive comment on “Reconstructing glacier-based climates of LGM Europe and Russia – Part 3: Comparison with GCM and pollen-based climate reconstructions” by R. Allen et al.

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General comments

This paper addresses an important topic for understanding the climate system. It tests the ability of GCM models to reconstruct the Last Glacial Maximum temperatures in Europe and Russia, in order to reliably predict future climatic change. The conclusion of this work highlights again the discrepancies between the GCM temperature anomalies (modern minus glacial temperatures) and those from previous pollen and new glacier-based reconstructions for this time period. The underestimation of simulated LGM temperatures could result from modelled modern conditions that are too

cold and LGM temperatures that could be too warm. Seasonality and model parameterisation effects can change the magnitude of the under prediction but still they do not match the reconstructed LGM temperatures. I think that this paper deserves publication but only if authors take into consideration the serious and little recognised problem of the unreliable chronology associated with pollen sites and glaciers and, therefore, the potential amalgamation of LGM and Heinrich (H) event climatic records.

Specific Comments

The chronology problem mentioned above raises an alternative hypothesis that can substantially explain the mismatch observed between GCM results and pollen and glacier-based climate reconstructions. This hypothesis should be put forward in the abstract and the conclusions of the paper. Only half of the pollen sites in Europe (7 out of 15) have a reliable chronology attributing these pollen assemblages to the LGM time interval (18,000 \pm 2,000 14C years BP) (Peyron et al. 1998). A more important drawback occurs for the pollen dataset from the former Soviet Union and Mongolia. In this large region, only 9 sites out of a total of 32 are reliably dated to this time period. Six sites are not dated and the remaining sites (17) have an ambiguous chronology meaning that the pollen assemblages might pertain to H1 (15,100-13,400 14C ky BP), H2 (22,100-20,400 14C years BP) or to the older ones (H3, H4, H5 and H6) (dates for Heinrich events after Elliot et al., 1998; 2002). We have recently demonstrated from eastern North Atlantic pollen sequences on the basis of the direct correlation between terrestrial (pollen) and marine climatic indicators that in southern and northern Iberia the LGM period was warmer and more humid than the Heinrich events (H2 and H1) bracketing it (Turon et al., 2003; Kageyama et al., 2005; Naughton et al., 2007; Fletcher and Sanchez Goñi, submitted). Also, several sea surface temperature records (for example, Cacho et al. 2001), shows warmer temperatures during the LGM than during H2 and H1 events. In the absence of a more robust chronological control for the dataset presented by Allen et al., these authors may be comparing GCM results for the LGM with the observed colder Heinrich event episodes. Therefore, the reconstructed climate

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anomalies will be always larger than those simulated by the GCM. Similarly, this paper and the related paper submitted at the same time to the *Climate of the Past* (Allen et al. Reconstructing glacier-based climates of LGM in Europe and Russia 8211; Part 2: A dataset of LGM climates derived from degree-day modelling of palaeo glaciers) do not present the available radiometric dates which allow the attribution of the different glaciers to the LGM period. Authors discuss this issue in section 5.4. However, this discussion should be expanded and moved to section 3.

In Section 4 - Initial comparison: lines 24 to 26 - authors say: "The pollen site closest to each glaciated region was used to drive the model and it was assumed that the LGM climate anomalies for each pollen site were spatially uniform across the glaciated region to which they were applied". Unless the pollen spectra are shown to be contemporaneous with the LGM, the model output may be already incorporating an error.

In Section 4.3 - Discussion of initial comparison: lines 9 and 10 - authors state: "...therefore the expansion of drought tolerant species (commonly reconstructed at the LGM)". In contrast with this assertion, we know now (Turon et al., 2003; Naughton et al., 2007; Fletcher and Sanchez Goñi, submitted) that from Heinrich event 2 to the LGM there is an increase in moisture and sea surface and air temperatures.

References

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Technical corrections

Abstract - line 10 - Replace " CGM " by " GCM "

Section 4.4 - Discussion - line 14 Delete "suggests" or "indicates". There is a verb repetition.

Figures 1, 2, 3, 4, 5, 6, 8 and 9 Replace "Si. de Ancarres" by "Si. de Ancares" and "Si. de Estrala" by "Si. de Estrela".

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