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Climate of the Past Discussions

Interactive comment on "Gridded climate data from 5 GCMs of the Last Glacial Maximum downscaled to 30 arc s for Europe" *by* D. R. Schmatz et al.

Anonymous Referee #1

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Review of Clim. Past Discuss., 11, 2585–2613, 2015 Gridded climate data from 5 GCMs of the Last Glacial Maximum downscaled to 30arcs for Europe D. R. Schmatz, J. Luterbacher, N. E. Zimmermann and P. B. Pearman

This manuscript aims to bridge the gap between climate model output (from GCMs above all) and the needs of climate impact models. While GCMs typically have a resolution of 100-300 km impact models often require much higher resolution, c. 1-10 km. One way to bridge this gap in resolution is to use the delta change factor method, which means that the the climate change signal is applied to an existing high resolved observational data set. Normally, this is a rather straightforward approach, but in the case of LGM things are more complicated since the land-sea mask in LGM

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and today is very different. The LGM sea level was about 125 m meters lower than today meaning that a lot more land was exposed during that time. For these regions there are no observations to use in delta change factor method. Schmatz et al. solve this by extrapolating existing data onto the LGM land surface asking the question "what would today's climate be if we had the LGM land surface?". By using linear regression modern day temperature and precipitation is adjusted for changes in elevation and distance to the coast. The difference in climate between pre-industrial (PI) time and LGM as simulated by a GCM is then applied to the extended observational data set to achieve a high resolved data set of LGM climate. The delta change factor method is not new, but I have never seen it applied on LGM. I'm sure there is a need for high resolved LGM data.

General comments

I am sceptical about this work, it seems to me that a lot of effort is made to add uncertainty to something already uncertain, and the gain of all this is unclear to me. The manuscript doesn't do anything do convince me of the benefits of this method. The end product (high resolved data sets of LGM climate based on 5 different GCMs) is not showed at all.

My greatest concerns are:

The gain of the method. On step in the delta change factor method is to interpolate GCM data to the higher resolution of the observational data set. This is the step that achieves the higher resolution. The next step, where the interpolated GCM data is applied to observation, adjusts the absolute values in the GCM climate so that any systematic biases are removed. This is the gain of the method. However, in central Europe LGM was 10-30 °C colder than today, depending on region and season. This is a huge difference in climate. If we lower the temperature with 20 °C, does it matter if we start from 16 or 18 °C in the present climate? Especially given the uncertainties in the GCM simulations. The inferred uncertainty from the delta change method may be

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of the same size as the bias in the GCMs. Since I'm not convinced of the method (see below) I'm not not sure if that is a risk I'm willing to take.

The representativity of "Worldclim extended". Points near the present coast line (on land or off shore) will be adjusted to be consistent with the new land-sea mask when the sea level i lowered. This means that some of the data in "Worldclim extended" is not representing real conditions. In the GCMs the PI time is modelled with PI topography and LGM with LGM topography. This means that in a grid box the difference between PI and LGM is not only a result of the difference in climate itself, but also differences in surface characteristics (sea, ice, land), elevation, distance to the coast etc. For example one reason that Scandinavia was colder in LGM was that it was covered by ice. When the difference in GCM simulated climate is applied to "Worldclim extended" it is applied to something that is adjusted to these differences. As I see it the simulated GCM climate is therefore applied to observations that are biased from reality.

The results. The result of this study should be a high resolved LGM climate. Very little is shown of this, only two panels in Fig. 5, and they only show one month for one GCM. What do the reconstructed climate look like in all of Europe? How do the results compare to the original GCM results? How do they compare to other simulations (for RCM simulations of LGM see e.g Jost et al. 2005; Strandberg et al., 2011)? How do they compare to proxies? The lack of results make it impossible to estimate the value and correctness of the model. Furthermore the presented LGM climate in Fig. 5c and 5d seems to be wrong. In LGM a large part of the domain shown in Fig. 5 was covered by an ice sheet. I don't expect the mountains in Scotland and northern England to influence temperature or precipitation (as they seem to be in Fig. 5) when they are covered by a few hundred meters of ice.

To conclude, to make this manuscript acceptable the results must be better accounted for. And it has to bee shown why these results are better than the original GCM simulations and why this method is better than a simple bilinear interpolation of the GCM data. As it is now the title "Gridded climate data from 5 GCMs of the Last Glacial Maximum

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downscaled to 30arcs for Europe" is misleading.

Specific comments

P. 2586, l. 4-6: "Another shortcoming of available datasets on past climate is that the effects of sea level rise and fall are not considered." This is not true, PMIP2 uses LGM topography (see e.g. Braconnot et al., 2007).

P. 2586, l. 16: "we calculate 19 'bioclimatic' variables". These variables are mentioned here and once in section "Summary and conclusions". What are these variables? How where they calculated, and why?

P. 2590, l. 1-3: "we assumed physical processes like air pressure, weather patterns, exposition, and geographic trends in solar radiation are unaffected by the exposure of additional terrestrial land area during LGM." It is not easy to answer the highly theoretical question "What would today's climate be if we had the LGM land surface?". Probably the general circulation would change which would effect temperature and precipitation.

P. 2595, l. 6-7: "Even though we intended to present downscaled climate data for Europe we used the area of the Yucatán Peninsula (Gulf of Mexico) to develop our method". I see the point of testing the model for different areas, but the reader of this paper is probably mostly interested in how the model performs for Europe. Why don't show that?

P. 2596, l. 26-27: "We therefore have to assume that the precipitation difference between current and preindustrial times is negligible." I see why this is necessary, but it is not true and adds to the uncertainties in the method.

P. 2597, l. 5: "the following GCMs". References to models and simulations are missing.

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Interactive comment on Clim. Past Discuss., 11, 2585, 2015.