

# ***Interactive comment on “Interdependence of the Northern Hemisphere ice-sheets build-up during the last glaciation: the role of atmospheric circulation” by P. Beghin et al.***

**P. Beghin et al.**

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**General comments** We thank Lauren Gregoire for her review. We have made a revisited version of the paper taking into account all remarks and comments of the reviewers. Here are the response to the specific comments :

## **Specific comments**

**P 2184 L11:** replace “Several parameterizations have been tested” by “We tested different parameterizations : : :”. Similarly in the rest of the manuscript, use the active form to emphasise what you have done in this study.

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The text has been modified accordingly

**P 2184 L23: remove second “be” in “be partly be”**

The text is modified

**P 2184 L14: “We show that the response of ice sheets to thermal and/or orographic forcings is rather different.” is an overstatement. What you show only relates to the parameterisations you use. You can only \*suggest\* that it applies to the real world. As you clearly point out in the manuscript, your parameterisations aren’t perfect and your results are influence by the low resolution of the model.**

The text has been modified to remove overstatements

**Give a bit more background to the gravity wave parameterisation in equation (2), what is it scientifically based on ? Similarly, there needs to be more background on the orographic term of the gravity wave parameterisation. Are there similar parameterisations used in other EMICS?**

In the original version of the CLIMBER model (Petoukhov et al., 2010), the azonal component of sea-level pressure is described by “using the interrelation between long-term large-scale azonal temperature and pressure fields in quasi-stationary planetary-scale waves. This relationship has been established by Blinova (1958)(this original publication is unfortunately written in Russian) and adapted for the CLIMBER resolution. This means that the phase shift between temperature and pressure fields has been neglected because it is below the resolution of CLIMBER-2. This led to the parameterization expressed by equation (2).

The parameterization described by equation (6) has been established following the same basic principle as equation (2). Since the thermal contribution is expressed as a linear relation between the azonal component of sea-level pressure ( $p'_{th}$ ) and the

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azonal component of temperature ( $T'_0$ ), we expressed the orographic contribution ( $p'_{oro}$ ) as a function of the deviation of orography from its zonal mean ( $h'_0$ ). This accounts for the deviation of the zonal wind by an anomaly of topography. Since the zonal wind is driven by the equator-to-pole temperature gradient, we added the term  $\Delta T_{E/P}$  in our parameterization to account for the effect of the temperature gradient. Adding a dependency on the equator-to-pole temperature gradient allows to account for seasonal changes of the influence of the orographic effect on the sea-level-pressure. The larger this gradient is, the stronger the zonal wind and the influence of topography are. At the opposite, if  $\Delta T_{E/P}$  is too small (i.e. below the  $\Delta T_{limit}$ ), the zonal wind and its deviation due to orography will be negligible. Therefore, the  $\Delta T_{limit}$  represents the limit below which the orographic contribution is negligible. We have tested numerous values of this parameter and have compared the SLP field for summer and winter with NCEP reanalysis. The numerical value of the  $\Delta T_{limit}$  parameter has been chosen in order to obtain the best correlation between our results and NCEP reanalysis, keeping a proper response to anomalies of topography (i.e. A high mountain leads to a positive SLP anomaly). Other choices could of course have been made, but the comparison of the overall SLP response (when both thermal and orographic effects are account for) with the NCEP reanalysis seems reasonable given the CLIMBER resolution. We added these explanations in the text.

**Equation 2: There is a 'P' that I think should be a lower case p**

The text has been modified

**P2191 L19 slp anomaly : write in full or define the SLP acronym and use upper case.**

The text has been modified

**P 2195: line 2: what do you mean by eastern longitudes ?**

Eastern longitudes correspond to 0° to 180°E. However, we acknowledge that the warming is not only produced over eastern longitudes but also over North Atlantic Ocean. We modified the text accordingly.

**P 2195 L5 “Over North America,: :”: Is there a word missing in that sentence?**

Yes, a word was missing. The text has been modified.

**Table 1 : describe the table ( eg. Table of experiments)**

We add a legend to the table.

**Figure 1 and text associated: In panel d, we see that the parameterisation of gravity waves produce a SLP anomaly of the wrong sign over North America. In the discussion, please comment on how this might influence the results.**

Actually, the comment of the reviewer is due to an artifact of the figure. We plotted the anomalies of SLP with shaded contours (Fig.1). We used this presentation because we thought that the figure can be more easily interpreted this way. However, plotting the same figure with actual CLIMBER grid boxes may leads to slight differences compared to our fig.1. We add below the same figure 1d plotted at CLIMBER resolution. This new figure shows that the SLP anomaly has the proper sign over North America, but its amplitude is weaker. The response of the case with only orographic forcing is closer to NCEP reanalysis in this region (high pressure stronger). The too weak high pressure over North America in the OTH case implies that the winter response should be closer to the ORO case, with more accumulation.

**Figure 2 : add snow before accumulation so that the figure can be understood without looking at the text.**

The text is modified

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**Figure 6 could benefit from a few labels (eg. describing lines and columns).**

We agree with the reviewer and the figure has been modified.

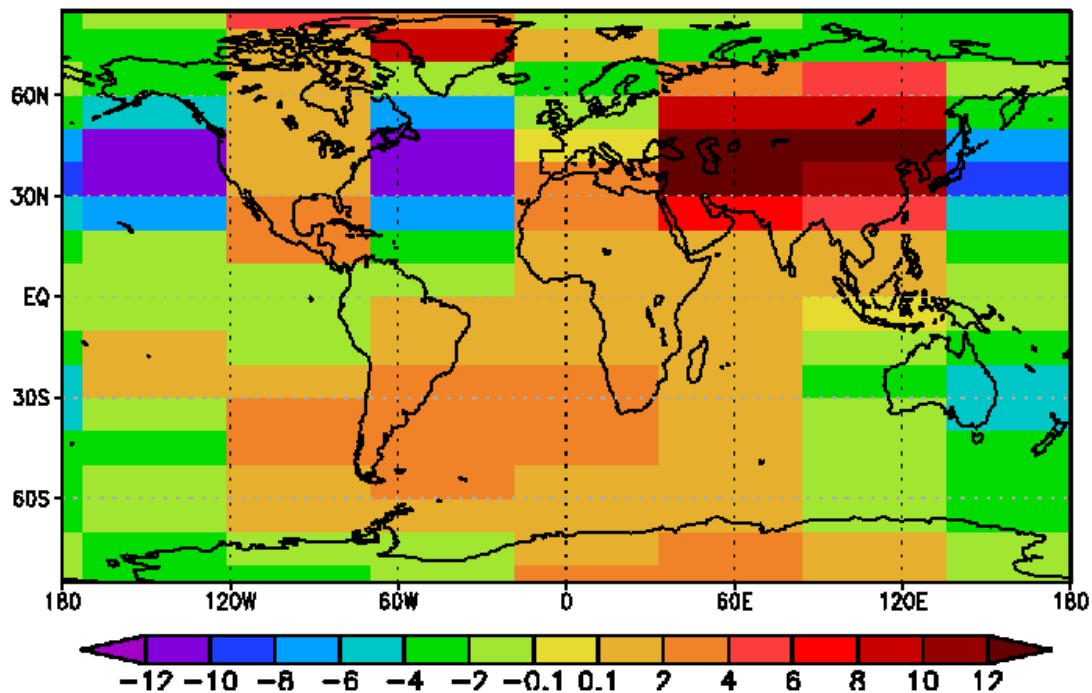
**Section 4: I found it hard to follow the description of the experiments. Please consider revising the text to make a flow a bit better and highlight the main results.**

We think that the description of the results was a bit difficult to read due to too long sentences. We changed the text in several places in order to make the section clearer.

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Interactive comment on Clim. Past Discuss., 9, 2183, 2013.

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**Fig. 1.** SLP anomaly for the OTH experiment (hPa). Same figure than figure 1d in the manuscript, with CLIMBER grid boxes.

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