

## Comments on :

### **A GCM comparison of Plio–Pleistocene interglacial–glacial periods in relation to Lake El’gygytyn, NE Arctic Russia.**

By A. J. Coletti, R. M. DeConto, J. Brigham-Grette, and M. Melles

This paper provides a comparison between climate simulations and reconstruction for several interglacial and one glacial period for Lake El’gygytyn. Comparison is given for temperature, precipitation and vegetation. The title of the paper reflects the content of the paper, although the dash between interglacial and glacial may be misleading, suggesting a transient instead of a snapshot comparison.

My general feeling about this paper is that it is a sloppy work (at least the writing) and that the paper was written in haste. At many places in the manuscript, the language is far from clear and precise. I would not say that it prevents the reading but it makes the reading very uncomfortable because the reader must ‘fill in’ missing information.

On a science point of view, I would qualify the study as decent/good master thesis work. It has indeed some interest (at least within the framework of the study of Lake El’gygytyn). I would certainly not say that it is a substantial contribution or a very novel piece of science. The work is mostly putting into a single paper information that already existed and was published, i.e. climate simulation and climate reconstruction from Lake El’gygytyn. But still, this kind of exercise has some interest.

### **General comments**

One or several references to Lake El’gygytyn related papers are deeply missing. The CP special issue could be referenced as well.

The tables describing the experiments should be revised for an easier reading.

Here is a suggestion for Table1 : Overview of the simulations

| Run name | Age (ka) | Run description | CO <sub>2</sub> (ppmv) | CH <sub>4</sub> (ppbv) | N <sub>2</sub> O (ppbv) | Ecc. | Obl. (deg.) | Prec. (deg) |
|----------|----------|-----------------|------------------------|------------------------|-------------------------|------|-------------|-------------|
|          | 0        | Pre-industrial  |                        |                        |                         |      |             |             |
|          | 0        | Modern          |                        |                        |                         |      |             |             |
|          | 9        | MIS1 with GIS   |                        |                        |                         |      |             |             |
|          | 127      | MIS5e with GIS  |                        |                        |                         |      |             |             |
| MIS11GIS | 409      | MIS11c with GIS |                        |                        |                         |      |             |             |
|          | ??       | MIS31 with GIS  |                        |                        |                         |      |             |             |
| MIS11NG  | 409      | MIS11c no GIS   |                        |                        |                         |      |             |             |

|         |     |                                  |  |  |  |  |  |  |  |  |
|---------|-----|----------------------------------|--|--|--|--|--|--|--|--|
|         | 409 | MIS11c no GIS 10Wm <sup>-2</sup> |  |  |  |  |  |  |  |  |
|         | ??  | MIS31 no GIS                     |  |  |  |  |  |  |  |  |
| 3NG116K | 116 |                                  |  |  |  |  |  |  |  |  |
| 3HL116K | 116 |                                  |  |  |  |  |  |  |  |  |

Table 2 could provide some results (temperature and precipitation) discussed in the paper.

|   | PI   | Modern | MIS1 | MIS5 | MIS11GIS | MIS11NG | MIS11 | MIS31GIS | MIS31NG | 3NG116K | 3HL116K |
|---|------|--------|------|------|----------|---------|-------|----------|---------|---------|---------|
| <b>Lake E.</b>  |      |        |      |      |          |         |       |          |         |         |         |
| MAAT (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| Temp JJA (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| MTWM (°C)   | 10.3 | 12.0   | 12.4 | 14.5 | 12.2     | 13.8    | 12.5  | 13.2     |         |         |         |
| MTCM (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| PANN( mm yr <sup>-1</sup> )   | 438  | 475    | 438  | 401  | 475      | 438     | 438   | 475      |         |         |         |
| <b>Arctic or Beringia</b> (depending on what is discussed in the main text) |      |        |      |      |          |         |       |          |         |         |         |
| MAAT (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| Temp JJA (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| MTWM (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| MTCM (°C)   |      |        |      |      |          |         |       |          |         |         |         |
| PANN( mm yr <sup>-1</sup> )   |      |        |      |      |          |         |       |          |         |         |         |

I agree that all the variables for both Lake E. and the Arctic may not be useful for the discussion and therefore the table could be simplified. This table would solve a major problem of the paper. The authors often give anomalies without giving the reference to which it is computed (either PI or Modern). It will also solve a second issue. The numbers seems not to be always coherent from one section to the other.

The description of experiments is not sufficiently complete and precise. For example, it is not clear whether the same Greenland ice sheet (altitude, extent, ...) is used for PI, Modern, MIS1, MIS5e, MIS11c, MIS31. In the case of MIS5e, the description of this interglacial states that Greenland ice core records suggest a modest reduction in the size of the GIS. In the discussion, the authors wrote 'our simulations of MIS-5e with a near-modern GIS'. However, it is not clearly mentioned whether a reduction of the size (or any other change) of the GIS compared to present-day (pre-industrial or modern) is applied for the simulations. Is the same GIS used for PI and Modern simulations? How realistic is it? As far as the orbital forcing is concerned, the authors stated that Earth's orbital configuration has changed little in 120 years (from PI to Modern, I guess). Has this modest change been taken into account? The authors should also check the orbital parameters for MIS31.

There are major defects all throughout the text. Very regularly, the authors forgot to mention their reference, which is either PI or Modern. I agree that the problem would not exist if there were only one reference! Very regularly, the authors forgot to mention the time in the year (Summer, July, Annual, ...) that applied on the provided values. Very regularly, the authors forgot to mention the region (Lake E., Beringia, Arctic) that applied to the provided values. This issue must be solved.

Several authors, including Yin and Berger (2011) that the authors quoted, selected peak interglacials for their study. However, they do not agree on the date corresponding to this peak interglacials. For example, for MIS1, Yin and Berger (2011) selected 12ka, Lisiecki and Raymo (2005) pointed towards 6ka and Melles et al (2012) choose 9ka. Could the authors elaborate on the reason for the difference (as well as for the other interglacials) and explain how they make their choice? By the way, peak of summer warmth may be different from peak of boreal summer insolation.

The authors do not seem to be aware of other modelling studies performed for the Eemian, such as

Bakker, P., Stone, E. J., Charbit, S., Gröger, M., Krebs-Kanzow, U., Ritz, S. P., Varma, V., Khon, S., Lunt, D. J., Mikolajewicz, U., Prange, M., Renssen, H., Schneider, B., and Schulz, M.: Last interglacial temperature evolution – a model inter-comparison, *Climate of the Past*, 9, 605-619, 10.5194/cpd-8-4663-2012, 2013.

Langebroek, P. M., and Nisancioglu, K. H.: Simulating last interglacial climate with NorESM: role of insolation and peak warmth, *Clim. Past Discuss.*, 9, 4449–4473, doi:10.5194/cpd-9-4449-2013, 2013.

Loutre, M. F., Fichet, T., Gooze, H., Huybrechts, P., Goelzer, H., and Capron, E.: Factors controlling the last interglacial climate as simulated by LOVECLIM1.3, *Clim. Past*, 10, 1541-1565, 10.5194/cp-10-1541-2014, 2014.

Lunt, D. J., Abe-Ouchi, A., Bakker, P., Berger, A., Braconnot, P., Charbit, S., Fischer, N., Herold, N., Jungclaus, J. H., Khon, V. C., Krebs-Kanzow, U., Langebroek, P. M., Lohmann, G., Nisancioglu, K. H., Otto-Bliesner, B. L., Park, W., Pfeiffer, M., Phipps, S. J., Prange, M., Rachmayani, R., Renssen, H., Rosenbloom, N., Schneider, B., Stone, E. J., Takahashi, K., Wei, W., Yin, Q., and Zhang, Z. S.: A multi-model assessment of last interglacial temperatures, *Clim. Past*, 9, 699–717, doi:10.5194/cp-9-699-2013, 2013.

## Detailed comments

Page (P.)3128 line(l.)18 - 'A prescribed enhancement of oceanic heat transport into the Arctic ocean has some effect on Beringian climate, suggesting intrahemispheric coupling seen in comparisons between Lake El'gygytgyn and Antarctic sediment records might be related to linkages between Antarctic ice volume and ocean circulation.' I do not understand this sentence.

P.3129 1.13 - I suggest using Lake E everywhere throughout the main text (from section 1 to section 4-included).

P.3131 1.19 – The authors should define **summer** insolation. The value they are giving for summer insolation seems rather large. However, it may be correct depending on their definition

of summer insolation. A reference for the insolation should be provided in the text (and not only in the table).

P.3132 1.6 – ‘(Dahl-Jensen et al., 2013) suggest warm conditions throughout the Arctic’. I think that Dahl-Jensen et al. (2013) suggest warm conditions recorded at NEEM site. How is it extrapolated for the whole Arctic?

P.3132 1.16 – ‘insolation plays a dominate role on the on precipitation’. Something is going wrong in this sentence.

P.3132 1.21 – ‘The simulation of LIG shown here is used to compare with the paleoenvironmental conditions in the Arctic during this period of and investigate temperature, vegetation and precipitation and correlate the data to pollen proxy analysis.’ Something is going wrong in this sentence.

P.3133 1.1 – I am not sure that the paper (Miller et al., 2010) is dealing with MIS11.

P.3133 1.1 – ‘insolation forcing ... was remarkably long’. I do not understand what this mean. Does it mean that the insolation (which one?) remains high over a long time interval?

P.3133 1.28 – ‘distributions of are used’ a word is missing preventing the understanding of the sentence.

P.3134 1.13 – What is ‘MIS model’?

P.3135 1.23 – ‘the GCM is only +0.5 °C warmer than the modern reanalysis data’ When? In Summer? In July? In annual mean?

P.3136 1.10 – ‘precipitation is rather dry’. I am sorry! This does not make sense to me. Please clarify what you mean.

P.3136 1.27 – Please avoid to write that temperatures are cooler/colder/warmer. Indeed a region can be cooler/colder/warmer than another but temperatures can only be larger/smaller/lower ...

P.3137 1.20 – Is this for Lake E or for Beringia or for the Arctic?

P.3137 1.7 – When? In summer or in July or in annual mean?

P.3138 1.12 – ppmv instead of ppm.

P.3138 1.15 - Is this for Lake E or for Beringia or for the Arctic? As long as there is a 2°C difference between PI and Modern simulation, it is difficult to understand that the comparisons to PI and to Modern are similar. Please explain.

P.3138 1.20 - Is this for Lake E or for Beringia or for the Arctic?

P.3138 1.26 – The reference to Fig4c is not correct.

P.3139 1.14 – What does ‘mean annual summer temperature’ refer to?

P.3140 1.9 – Is modern value 478mm yr<sup>-1</sup>?

P.3140 1.11 – The reference to Fig4d is not correct.

P.3141 1.2 - Is this for Lake E or for Beringia or for the Arctic?

P.3141 1.7 – Is it really for the Arctic? I thought that it was for Lake E.

P.3141 1.21 – ‘more than’ instead of ‘more then’. What is the reference here? 150mm yr<sup>-1</sup> decrease compare to what?

P.3142 1.13, 1.16 – This seems to contradict numbers previously given. I am sure that this will be immediately clarified with the revised tables. There are three MIS-11c simulations. Which one is referred to here?

P.3142 1.21-22 – What do the authors mean with ‘thermal maximum are variable’? Does it mean that thermal maximum has a large variability measured with a large standard deviation? In that case, why could the authors conclude that it is large? What is their reference for such a conclusion? ‘smaller anomalies reconstructed ...’ Which anomalies are the authors discussing? What is the reference, i.e smaller than what? Why is it so?

P.3143 1.3 – ‘a reduction in the Greenland Ice Sheet adding 1.6 to 2.2 m of equivalent sea level rise’. Adding water to what? To which reference sea level?

P.3143 1.6 – ‘the thickness decreased by ‘. Once more, what is the reference? A decrease from what?

P.3144 1.5 – In this simulation, the authors increased the heat flux convergence under sea ice in the Arctic Ocean. I assume that the reduction in sea ice fraction and the summer warming are not prescribed but rather a consequence of the increased heat flux. This should be made clear. The reference to Fig3a is not correct.

P.3144 1.21 – Is this statement valid for MIS11 (i.e. deduced from the comparison between MIS11GIS and MIS11NG) or is it more general (deduced maybe from additional simulations not shown)?

P.3145 1.13 – ‘atmospheric CO<sub>2</sub> was higher’. Higher than what? I suggest that the authors explain in more details what they have in mind with this sentence.

P.3145 1.23 – It was stated that PANN for the Modern simulation was 475mm yr<sup>-1</sup>. This is NOT 350mm yr<sup>-1</sup> less than 600mm yr<sup>-1</sup>. This should be clarified.

P.3146 1.6 – Starting from here, the discussion focuses on the 116K simulations. This should appear more clearly in the text.

P.3146 1.19 – The authors seems to explain the aridity during the 116K simulations with more frequent storms. Actually, I would guess that more frequent storms would drive more precipitation. Can this be clarified?

P.3146 1.26 - The reference to Fig6a and b is not correct, at least if the discussion is still about July. If not, this must be clearly stated.

P.3147 1.8 - Is this for Lake E or for Beringia or for the Arctic?

P.3148 1.1-4 – I assume that this comes from data (observation) or did one/several of the simulation account for changes in the GIS?

P.3153 - I already made suggestions and comments about table 1. Here are a few additional ones. It is written that ‘precession is  $\Omega$ ’.  $\Omega$  must be defined and the units must be provided. It is written that ‘temperatures are mean July temperatures’. I assume that they are for Lake E. There is no explanation about Prec in the caption. The reader can but assume that it is annual mean precipitation simulated at Lake E. Is this correct? The obliquity at MIS1 may be 24.229 instead of 24.29. This should be checked.

P.3155 - Which calendar is used for this plot? Orbital calendar? Present-day calendar (360 or 365 days)? The resolution of the plot seems to be better than ‘monthly’ or is it the interpolation from the graphic tool?

P.3156 – Are these plots for annual, summer or July temperature? ‘Area of no shading (white)’. I am sorry, I do not understand what this mean. Actually the white shading, according to the color bar, corresponds to zero warming. It is therefore difficult to imagine how it also represents statistically significant anomalies. At last it is surprising to label these figures as **warming** relative to PI while there is also cooling.

P.3157 – Figure A is most probably pre-industrial vegetation rather than modern vegetation. It should be mentioned if figure D is MIS11GIS or MIS11NG.

P.3159 – What is Polar MM5 regional climate model? It is not discussed in the main text.

P.3161 – The caption indicates that figures show anomalies with respect to the simulations without NH ice sheet. Actually, anomalies can be computed with respect to one simulation (at least one at a time). Which simulation (name) is used here? Strictly speaking ‘MTCM temperature’ is a bit awkward, indeed when the acronym is expanded it reads Mean Temperature of the Coldest Month temperature.

**In conclusion**, it would not be fair to reject the paper for language reason. However, I recommend an in-depth revision.