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Climate of the Past Discussions

Interactive comment on "Modeling the climatic implications of the Guliya δ^{18}O record during the past 130 ka" *by* D. Xiao et al.

Anonymous Referee #2

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The authors made an interesting effort trying to understand better the climatic significance of the Guliya delta 18O through climate modeling. This approach is new to my knowledge. It is certainly an interesting and important topic given the unique location of the Guliya ice core. However, in order to make their conclusions more convincing and their analysis more in depth, the following points must be improved and answered.

Major concerns:

1. The research motivation should be more clearly addressed in Introduction.

2. Regarding the experiments, information on initial conditions and boundary conditions is needed. Are other climate forcings (e.g. ice sheets, greenhouse gas concentration, ...) kept constant through the whole simulation? How long did the model take

in real time for 1308-year long simulation? Is it worth to use acceleration for an intermediate complexity model? The readers may also want to know the disadvantage and possible bias induced by the acceleration technique.

3. P1891, 2nd paragraph: The authors only described Fig1 and did not attempt to give any explanation. I suggest they plot the similar figure as Fig1 but for insolation to see if the variation of SAT can be explained by variation of insolation. Moreover, the last sentence of this paragraph must be corrected because the fact that the insolation distribution differs between months is well known from the astronomical theory of Milankovitch 1941 and Berger 1978.

4. 3rd paragraph of Section 3:

(1) More details about the correlation between Guliya delta 18O and simulated temperature should be given. What is the phase relationship between delta 18O and each monthly temperature? If such a phase is taken into account, what is the impact on the conclusion? What is the accuracy of the time scale of the delta 18O, and its impact on the result?

(2) The authors try to determine to which month SAT the delta 18O is the most correlated by comparing their simulated monthly temperature with delta 18O. How does it compare with the correlation obtained from statistical analysis of delta 18O and monthly temperature provided by modern observation?

(3) The conclusion that the Guliya delta 18O represents late-summer temperature is not convincing enough before answers to the questions in (1) and (2) above are provided. Nevertheless, even if one accepts this conclusion, the mechanisms which link the late-summer SAT with the delta 18O must be explained.

(4) Based on the high correlation between the Guliya delta 18O and NH summer temperature, the authors conclude that the delta 18O represents not only local temperature but also the NH one. This can be easily questioned because (i) high correlation may

CPD
8, C770–C775, 2012

due to their similar response to a common forcing (insolation); (ii) ice sheets which may play important role in the mid-high latitudes are not taken into account in this paper as far as I see; and (iii) the Guliya delta 18O in figure4 shows strong precessional signal but weak obliquity signal and much less clear 100-ka glacial cycle. Is this the case in other NH paleo-records? The authors could compare the Guliya delta 18O with other proxies from different latitudes in the NH to see if Guliya delta 18O represents well the NH temperature.

5. I try to understand what is the purpose of comparing the climates between the warm and cold phases in Section 4. Please address this more clearly.

6. Section 4:

(1) The author should give explanations about the temperature changes described in both 2nd and 3rd paragraphs. They may first check what are the differences in astronomical parameters and in insolation between these warm and cold phases, and then look if these differences can explain their simulated temperature change.

(2) I understand that the authors would like to investigate the impact of obliquity and precession on the differences between the two anomalous patterns in Fig7. However, why not use directly obliquity and precession curves in Fig8 instead of the simulated Arctic temperature? I suggest therefore to replace the Arctic temperature curve by the precession and obliquity curves in Fig8. If they do so, according to the drawing I have made, they might find that for the first type of anomalous pattern, the precession minima (maxima) and obliquity maxima (minima) are more or less in phase which strengthens the insolation anomalies (positive or negative) in the NH summer, and for the second type of anomalous pattern, they are more or less anti-phase which weakens the insolation anomalies in the NH polar latitudes (similar discussions on the impact of precession and obliquity on insolation and climate can be found in Yin and Berger 2012 Climate Dynamics 38,709-724 and in Yin and Berger 2010 Nature Geoscience 3(4),243-246). It is therefore not appropriate to say in lines 10-11 of page 1894 that

CPD
8, C770–C775, 2012

the second pattern is mainly influenced by precession. It is influenced by both obliquity and precession but these two counteract with each other. The same remains for lines 11-13 of page 1895 and in Section 6.

7. Page 1895, L19-20: it would be nice to confirm the authors' conclusion by comparing the Guliya delta 18O and a SST proxy from North Atlantic.

8. One of the important conclusions of this paper is that N. Atlantic SST leads the Guliya late-summer SAT by 2.5ka. Can the author find a justification for this phase relationship by comparing the Guliya delta 18O and a SST proxy from North Atlantic? Speculations are made in the 3rd and 4th paragraphs of Section 5. In order to make this conclusion solid, the authors could do some additional sensitivity experiments to test the impact of North Atlantic SST on the Guliya temperature (these kinds of experiments would not take long time for a model of intermediate complexity).

9. Page 1896, L6: "..demonstrating that the Guliya late-summer precipitation leads the Guliya temperature", Can the authors find justification from the modern observation? What is the mechanism here?

10. Page 1896, L7-L14: A relationship between North Atlantic SST and the Asian monsoon precipitation was indeed found in some previous studies. However, the precipitation in Fig13 shows anti-phase with NH summer insolation, which is opposite to the monsoon signal recorded in the Chinese stalagmite. Therefore one may wonder whether the previous rule related to monsoon can still be applied to the simulated Guliya precipitation.

Other concerns:

1. The first paragraph of Introduction is not necessary because it is of no help and only diffuses the main message. By the way, it is not appropriate to call glacial or interglacial stage as "events".

2. P1887, L24: the local monthly

CPD

8, C770–C775, 2012

3. P1888, 2nd paragraph: The first sentence has no sense. Moreover, for the relationship between astronomical parameters and insolation, one can only refer to Milankovitch 1941 and Berger 1978. The last sentence is not logical, because June insolation at 60N is not necessarily equivalent to June SAT.

4. P1888, 3rd paragraph: the appearance of SST is too abrupt. It is better to give some explanation on why you want to investigate the relationship between delta 18O and SST, and where and which season.

5. P1888

L23: change “cycles” to “distributions”, “modulated” to “induced”. Change everywhere in the paper “solar insolation” to “insolation” or “incoming solar radiation”, and “orbital” to “astronomical”.

L24: change “ultimate” to “most probable”

L25: delete “millennial-“

6. P1890:

L15: annual or seasonal temperature?

L22: change “during” to “between”? “high and low phases” are unclear expressions.

L26: the simulated Guliya temperature

7. P1891:

L2: delete “It is known that”

L3: change “varying earth orbital parameters” to “precession”

L4: change “over” to “between”

L2-L6 lack logic and more explanation are needed for clarity.

8. P1891, L10: I guess it is better to replace “dominant” by “the largest”

CPD

8, C770–C775, 2012

9. The authors have shown that the spectrum of the Guliya delta 18O shows 20.762 precession period, but why do they mention many times 23-ka precession cycle in the delta 18O? Precession has two main periods, 19ka and 23ka (Berger, 1978). On average, 21ka is often used.

10. P1892:

L4: change “modulated” to “controlled”

L5: It is hard to see the obliquity cycle in the simulated temperature in Fig4. Please provide a figure showing the spectrum analysis of the simulated temperature.

L18: change “generally represents” to “contains”

L19: it seems a broken sentence. “their” means what?

L23-L25: Please provide a criterion for defining the periods of warm and cold phases?

11. P1890, 2nd and 3rd paragraphs: It is better to give explanations on why these analyses are needed.

12. More details on the UVic model are welcome. Discussions on its capacity in simulating the climate particularly over the studied region and studied climatic variables (temperature, precipitation, . . .) are also necessary.

13. P1891: L14-L16 are logically not understandable.

14. Which SST is used in figure12, summer, annual,. . .?

Interactive comment on Clim. Past Discuss., 8, 1885, 2012.