

Interactive comment on “Sources of holocene variability of oxygen isotopes in paleoclimate archives” by A. N. LeGrande and G. A. Schmidt

Anonymous Referee #2

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General comments This was an interesting paper, which included a number of insights into the climate of the Holocene and the relationship between $\delta^{18}\text{O}$ and climate. I suggest that the paper is accepted for publication subject to a number of revisions.

The end of the introduction section mentioned that the paper quantified “the impact of orbital variations, greenhouse gas variations and ice sheet variation in order to (1) examine the amount of variability of the proxy records compared to climate, (2) assess the skill of the model in reproducing the Holocene climate variability, and (3) suggest improvements to the interpretation of isotopic data from this period”. These aims are indeed important, and if dealt with properly could lead to a excellent paper. However, while some of these aims were dealt with in the paper some were not. For example, I did not see how the impact of orbital variations, greenhouse gases and ice sheets

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had been quantified, as they were all inextricably intertwined within the simulations. In addition, those issues that were dealt with had details scattered around the text which left the reader uncertain of the most important conclusions of the paper. I would like to see the sentence from the end of the introduction copied to the conclusions with the author’s comments about how each point had been addressed. If the paper could clearly explain these points then its conclusions would be much stronger.

The abstract mentioned that a number of model-data comparisons were performed, however this part of the paper was mainly limited to data over Asia, and was not sufficient to validate the model results over much of the globe. In addition it would be helpful if the authors could explicitly state exactly how the results could help with the interpretation of paleodata (see point above). This information is probably already in the paper but could be easier for the reader to extract.

Although the paper was said to describe 8 simulations of timeslices between 0ka and 9ka, most of the paper was limited to a description of the 9ka, with simulations from 1ka-5ka barely mentioned. Given that paleodata archives are generally time varying, but from a fixed spatial location, it may be more helpful to remove some of the spatial maps, but consider how $\delta^{18}\text{O}$, T and P vary through time at a number of locations. A discussion of this would also mean that the full range of simulations were properly included in the paper.

The authors noted that there was a slowdown in the THC in the 9K experiment due to the melting LIS. The natural question from this is whether this leads to an 8.2ka event, and if so how it compares with the author’s previous 8.2ka event experiments.

Many of the figures have only been referred to briefly in the text and some have not been referred to at all. For example, figure 4 contains 12 subfigures but only one (the 9K SSS) figure has been discussed in any detail; the $\delta^{18}\text{O}_c$ plots have not been mentioned at all nor have the 9K less ice volume effects. If the figures are not important enough to discuss they should be removed

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Specific comments

Introduction Line 2 – the definition of delta is misleading it implies $\delta = R_{\text{sample}} / R_{\text{std}}$, which is not what the authors meant. This would confuse someone new to the subject. Introduction Line 7 – define what is meant by “short time periods”, daily, monthly, annual, interannual etc. P1135 line 20 – need to define “temporal gradient” and “spatial gradient”. I am assuming that you mean relationship between temperature and $\delta^{18}\text{O}_p$ or similar, but more clarification is needed. Further you need to add more references here. P1136 Line 10-15 More recent work Sime et al 2008 suggest this is the relationship between T and $\delta^{18}\text{O}_p$ over Antarctica may not be linear. It could be worth mentioning this. P1136 Line 29, specify whether you will look at $\delta^{18}\text{O}_p$, $\delta^{18}\text{O}_{\text{sw}}$ or both P1137 Line 22 R_{std} and R_{snow} should still be defined, even though most readers will know what they mean. Section 3. It would read easier if the authors specified dates (ie 9kya, 6kya etc.) rather than using EH, MH and LH. In addition they have on several occasions written “EH to MH” or similar which makes no sense since there was no simulation between 9ky and 6kyr. If they mean both simulations they should write “9kya and 6kya”. P1138 Line 21. On figure 2 it looks like the 2-3degC warming occurs only at high latitudes. I would be surprised if this was the NH average P1139 Lines 7-8. Figure 3 suggests that Arctic anomalies are larger in DJF than in JJA, but the text suggests otherwise – please explain. P1139 Line 22 - Do they have a dynamic ice sheet model coupled to their GCM or is the melting imposed as a ‘flux correction’? Please specify. If it is added as a flux correction please specify the amount of freshwater input to the Labrador Sea (in Sv) and the $\delta^{18}\text{O}$ value of this (in per mille). P1140 line 23-28, are the climate changes referred to the annual mean or the JJA P1141 lines 1-3. Figure 2 suggests that 6ka comprises a combination of heavier and lighter $\delta^{18}\text{O}_p$ with the continents generally being depleted. However the text suggests heavier $\delta^{18}\text{O}_p$ throughout. Please clarify. P1141 line 9. Are you referring to the DJF front between Greenland and Scandinavia, if so please specify. Would this front be visible in actual $\delta^{18}\text{O}_p$ (not anomalies) or is it too small. P1141 lines 23-25 ‘large magnitude changes’ relative to 0k or large interannual variability. P1142 line 25, I

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don’t think Rozanski et al 1993 considered landward transport of water vapour from the oceans. P1143 line 2, “mid to early Holocene”. Do they mean “At 6k and 9k”? P1145 line 17. Is this a complete shutdown, or just a slowdown, how does it compare with the 23% reduction in NADW formation mentioned earlier? P1145 line 27 Mention you are now talking about $\delta^{18}\text{O}_p$ at Vostok Summit. P1146 line 2-4 I didn’t understand this!

None of the figures have units on the colorbar Figures 2, 3, 4, and 7 are too small The numbers on the right of 2 3 and 4 have not been defined Figure 3 caption: boreal winter and summer are labelled wrong. Figure 5 is a very complicated figure which is only given 1 line in the text, surely the statement P1140 line 4 could be validated using a much simpler figure. If the authors feel there is additional important information in figure 5 then it should be discussed in the text. Also it was not explained what all the different dots from each experiment represented. Figure 8 the caption needs rewriting so it is clear what everything is.

Technical corrections

Minor comments P1139 Line 8 - Grammar error “Water production temperatures”. P1148 line 2-3 grammar

Interactive comment on Clim. Past Discuss., 5, 1133, 2009.