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Interactive comment on "Quantifying molecular oxygen isotope variations during a Heinrich Stadial" *by* C. Reutenauer et al.

Anonymous Referee #2

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Reutenauer et al. present a modeling study of a Heinrich type event to try to understand the positive d18Oatm anomalies observed in ice cores during these events. For that purpose they combine modeling results from an AOGCM with an oxygen isotope enabled AGCM. They further use a land model to compute PFT and GPP.. Simulated changes in d18Op and vegetation types are compared to available paleoproxy records. Estimating changes in d18Oatm is complex and as far as I know it is the first modeling study of its kind. This study is quite interesting and novel and is worth publishing in Climate of the Past after addressing the comments below.

1) The conclusion of the paper is that d18Oatm increases during H events because of hydrological changes, which in turn affect the vegetation. Given the results of Figure 4a I would have expected a decrease in d18Op over vegetated areas, contrarily to

what is shown in figure 8b. It seems that the only region with positive d18Op and vegetation cover is over China and Southeast Asia. There is a large positive d18Op region between 0-20N in Africa, but it is associated with bare soil, so should not impact the GPP-O2 weighted d18Op. These changes would then overcompensate for the simulated negative d18Op in the Southern Hem. and over Europe. The zonal mean GPP-O2 weighted d18Op is shown in figure 9, but it looks surprising to see such a small effect in the latitudinal band 0-30S. Maybe a GPP-O2 weighted d18Op anomaly map might help.

In addition, simulated precipitation anomalies between HS and LGM should be shown, as it would considerably help understand the processes at play. Why is d18Op increasing over South East Asia? Moreover, in its present state figure 3b is not informative and d18Op anomalies between HS and LGM as shown in Figure 4 is much better. Figures 3 and 4 should thus be reorganized to reflect these changes.

If the drier (?) conditions over Southeast Asia are the main driver of d18Oatm, then the Southeast Asian Monsoon changes should play a significant role. The processes and robustness of this result should be briefly discussed. At the moment, there are some apparently contradictory statements in the text: P11, L. 7-9: "However, the model does not simulate an Antarctic warming or weakened East Asian Monsoon (noted EASM hereafter) (Kageyama et al.,2009)." P17, L11-13: it is stated that the model reproduces the weak Asian monsoon.

2) It is shown in equation 2 that the gross O2 fluxes from terrestrial and oceanic origin should have a similar impact on d18Oatm. Section 4.1. briefly discusses the possible changes in d18Omar and rules out pretty quickly an oceanic origin. I understand the current explanation for changes in d18Oatm involves changes in low latitude terrestrial processes. While the authors and this hypothesis is most likely correct, it is quite worthwhile to discuss the potential impact of changes in marine export. In order for section 4.1. to be very useful, a bit more caution should be used. There are still quite some uncertainties associated with the global change in oceanic export production,

with some large regions (i.e. EEP), where the net change is quite unknown. A more robust approach would be to examine the impact on d18Oatm of -10 to +10% change in export. If a +10% change in export production has no significant impact on d18Oatm, then oceanic processes could be ruled out with confidence. If not then it should be acknowledge that there is room for uncertainties.

3) Additional information about the models and uncertainties associated with experiment design. Model IPSL-CM4 resolution should be in degrees or km Since it is a central part of the paper, more information is needed about LMDZ4.

Design of isotopic experiments: SST and sea ice fields during HS-exp are used to force the oxygen isotope enabled atmospheric model. SST and sea ice anomalies will impact air temperature, precipitation and evaporation. These 3 effects will be recorded in d18Oprecip. However, two potentially important factors are neglected: if HS are driven by meltwater input from an icesheet, then 18O depleted water was added to the North Atlantic, thus lowering North Atlantic surface d18O. In addition, climatic changes occurring during HS will impact surface ocean d18O everywhere. Thus the d18O signature of the source water during evaporation would have changed as well. This effect should lower d18Op in the Atlantic region sites, where few proxies exist. One sentence or two about the associated uncertainty could be added.

4) P17, L15: It is stated Greenland ice cores suggest a 4 permil d18O decrease, whereas a 1.6 permil decrease is simulated. I don't know if the term "consistent with available data" is appropriate here. This discrepancy is most likely due to the weak cooling simulated over Greenland in the IPSL and should simply be acknowledged.

5) Please note that legend of figure 4 might be wrong: "comparison of d18O precipitation anomaly"

Typos: Figure 1: L 4 "by using" P21, L. 26. Unnecessary d18Olw?

P26, L. 12: "IPSL"

Figure 8: 2 a) iof a) and b)

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