Clim. Past Discuss.,
https://doi.org/10.5194/cp-2019-52-RC2, 2019

Climate of the Past Discussions

Interactive comment on "A dynamical reconstruction of the Last Glacial Maximum ocean state constrained by global oxygen isotope data" *by* Charlotte Breitkreuz et al.

Anonymous Referee #2

Received and published: 13 June 2019

The authors used the coupled ocean-sea-ice MIT general circulation model to estimate the LGM circulation state based on anomalies of reconstructed SSTs and foraminiferal oxygen isotopes. The approach is innovative and supports the growing evidence that the LGM circulation state was not necessarily associated with a shallower North Atlantic Deep Water and stronger Antarctic Bottom Water. Below are mostly minor recommendations that the authors may want to consider:

1. P4/L3, P6/L28: d18o anomalies are used in order to eliminate species specific vital effect. Generally, the use of anomalies is a good idea, because it minimizes constant laboratory offsets or systematic habitat effects, i.e. if seasonal or vertical

temperature changes are correlated. However, it is important to keep in mind that not all vital effects are constant, but might also change with environmental conditions. For example, changes in pH or light conditions can affect the d18O composition of foraminiferal shells. I find the use of anomalies reasonable, but suggest that the authors adapt their justification accordingly.

2. It is not entirely clear to me how the LH-LGM d18O anomalies of foraminifera have been exposed to the model. Have the differences between LH and LGM been added to the run of Breitkreuz et al. (2018) or are the anomalies the raw differences derived from the data? What is the exact time slice for the late Holocene, the last 2 kyrs or the last 4 kyrs? Please expand.

3. P3/L19/20/Table 1: Note that not all d18O data from Völpel et al. (2019) are of late Holocene age. The top of GeoB9510-1 is at least of mid-Holocene age (see Figure 2 & 3 in Völpel et al., 2019). Please clarify.

4. P2/L3: The authors write "Many studies indicate the presence of a shallower NADW and a more sluggish AMOC during the LGM compared to today (Lynch-Stieglitz et al., 2007". Actually, Lynch-Stieglitz et al. are quite vague on this point and mention evidence for both interpretations, a deeper and a shallower NADW. For example, they write "...this finding suggests that waters originating in the North Atlantic also contributed to the deep (>2km) water mass in the LGM Atlantic. This also argues against a much slower circulation for both deep-water masses in the Atlantic.". I suggest to cite specific papers for both scenarios.

5. P16/L13: "Only single data points show a mismatch in areas where other data points indicate agreement (Fig. 2)." Can the authors be more specific on potential reasons why these data points are different? Is it a specific proxy that does not work? Are there differences in sedimentation rate?

6. It would be interesting to know, to what extent the modelled LGM surface water d18Ow is consistent with reconstructions. For example, Duplessy et al. (1991,

Oceanologica Acta 14, 311-324) have reconstructed water with high d18O/salinity near 30-40°W, north of the polar front.

7. P13/14/17: The authors compare the LGM state with a modern state from Breitkreuz et al. (2018), which they denote “Late Holocene” (LH) estimate. Is this strictly correct and the experiment truly representative for the late Holocene, considering that the Breitkreuz et al. (2018) runs have been constrained with modern (past 1950) oceanographic data? These data might already contain a global warming signal.

Minor points

-P1/L8: (check in entire text): “benthic as well as planktic data on the oxygen isotopic composition of calcite”, better “oxygen isotope ratio of benthic and planktic foraminifera”

-P1/L15: Cite Mix et al. (2001) for the definition of the LGM time slice

-P3/L10: “Massachussets” must be “Massachusetts”

-P4/Table 1/References: “Völpel et al. (2018)” must be “Völpel et al. (2019)”

-P17/L14: Also cite Zahn & Mix (1991, doi:10.1029/90PA01882)

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2019-52, 2019.