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Interactive comment on "Glacial δ^{13}C decreases in the western South Atlantic forced by millennial changes in Southern Ocean ventilation" *by* Marília C. Campos et al.

Anonymous Referee #2

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Review of "Glacial d13C decreases in the western South Atlantic forced by millennial changes in Southern Ocean ventilation" by Campos et al.

The authors use the d13C of planktonic foraminifera to infer variability in the d13C of DIC in surface/thermocline waters in the SW Atlantic. One strength of the paper is the comprehensive review of the modern oceanographic setting. Another is that the planktonic time series are based on a sediment core with very high sedimentation rates, allowing for high resolution reconstruction of surface ocean d13C during Heinrich Stadial 2 and 3. It is also important that the authors used two different species to reconstruct d13C (one surface dwelling and another thermocline dwelling) to account for potential biases in habitat and vital effects that could overprint changes in the d13C

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of DIC. Given the high resolution and replicated nature of the record, the authors clearly show that this part of the Southwest Atlantic underwent significant changes in d13C during Heinrich Stadial 2 and 3.

The primary weakness of the paper is the interpretation of the d13C and sedimentation rate results. The authors are quick to assume that their d13C records reflect the input of light carbon from the Southern Ocean and neglect other possible explanations that are well documented in the published literature. The authors also invoke speculative connections between rainfall and sedimentation rate in the core as support for their climate interpretation, despite disagreement between the sedimentation rate and planktonic d13C patterns. Finally, the authors neglect to mention much of the work at the Brazil Margin spanning the last deglaciation (including Heinrich Stadial 1) that is both relevant to their work and inconsistent with a Southern Ocean driver.

Major issues:

While the prevailing view is that Southern Ocean outgassing drove surface ocean d13C anomalies during the last deglaciation, the authors also need to reference to Andreas Schmittner's work that shows that weakening of the AMOC can alter the preformed nutrient budget of the global ocean and therefore the efficiency of the biological pump. Weakening of the biopump would preferentially leave light carbon in the surface and create negative d13C anomalies in multiple ocean basins (e.g. Schmittner, 2005; Schmittner and Galbraith, 2008). Also, detailed reconstructions from the Brazil Margin show that benthic d13C and d18O changed late in the deglaciation, suggesting that the abyssal ocean was an unlikely source for the surface ocean anomalies during HS1 (Lund et al., 2015). Additional published records from the SE Atlantic shows a similar pattern, with a late deglacial response in the abyssal records (Waelbroeck et al., 2011; Roberts et al., 2016). Furthermore, intermediate depth d13C reconstructions from the Brazil Margin (Oppo and Horowitz, 2000; Curry and Oppo, 2005; Lund et al., 2015) imply that AAIW and SAMW were not carriers of a light carbon signal during HS1, which is inconsistent with the mechanism invoked by Campos et al. While the authors did a commendable job summarizing the literature pertaining the modern oceanographic setting, the introductory material includes surprisingly little information from previously published work along the Brazil Margin. As a result, the introductory material is incomplete and the lack of context limits the interpretation in the discussion section.

The other main issue with the data interpretation is that the continental hydroclimate response isn't well supported by the sedimentation rate data. While sedimentation rates peak early in HS2, at about the same time as a planktonic d13C minimum, there is a second peak in sedimentation rate after HS2 that corresponds to a broad maximum in d13C. Furthermore, there is no peak in sedimentation rate during either HS3 or HS1. Taken as a whole, the sedimentation rate data therefore do not support a continental hydroclimate connection, which perhaps isn't surprising given the many factors that can influence sedimentation rates at a single core site.

Finally, the manuscript would benefit from inclusion of the planktonic d18O data. If there is a clear hydroclimate signal at this site, it could appear in the d18O data as intervals of unusually low d18O. The d18O data would also be informative for assessing the influence of air-sea gas exchange effects on the d13C signal. The d13C of surface ocean DIC is influenced by temperature dependent gas exchange, with a relationship of $\sim$ -0.1 per mil per deg C of warming (Broecker and Maier-Reimer, 1992; Lynch-Stieglitz et al., 1995). While such an effect is unlikely to explain the full magnitude of the d13C signals, it should be included in the discussion. Model results suggest that weakening of the AMOC warms the upper subtropical South Atlantic by 2-3 deg C (Marcotte et al., 2011) which would account for up to 0.3 per mil of the planktonic d13C anomalies.

Minor issues:

Page 6, Line 12: Here the authors should consider the possibility that weakening of the biological pump could have produced d13C anomalies not only locally, but on a larger

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spatial scales.

Page 6, Line 20: It is important to mention that published mode and intermediate water records from the Brazil Margin either show a positive d13C anomaly during HS1 or a delayed negative d13C response that is inconsistent the light carbon being transported northward via mode and intermediate water.

Page 7, Line 5: The authors seem to take it as a given that Southern Hemisphere westerlies drives greater upwelling of deep waters when it actuality there is limited data to support such a link. Please qualify these types of statements to reflect the limited constraints that exist.

Page 7, Line 9: See comments above that published intermediate depth records from the Brazil Margin don't show clear negative carbon isotope anomalies during HS1, which is relevant to whether a similar process occurred during HS2 and HS3.

Figure 4: If the authors are going to pursue the sedimentation rate-hydoclimate link, then the sedimentation rates should also be included in this figure for comparison to the d13C. The d18O records should also be included to assess the potential impact of sea surface temperature on d13C.

Figure 5: There are several time series in this plot that aren't essential for the discussion, such as the Iberian Margin SST record, the EDML d18O time series, and the Siple Dome CO2.

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