Interactive comment on "A south Atlantic island record uncovers shifts in westerlies and hydroclimate during the last glacial" by Svante Björck et al.

Anonymous Referee #1 Received and published: 4 July 2019

General comments: Björck et al. generated a multi-proxy record from a sediment core in a mid-latitude island of South Atlantic Ocean covering the last glacial (36.4- 18.6 ka) to reconstruct temperature and hydroclimate changes, both of which were linked with latitudinal movements of the southern hemisphere westerlies. PCA was used to reduce the dimensionality of multi proxy data. Isotope-enabled GCM was also included to investigate the controlling factors on precipitation d2H in the study area. The new South Atlantic record was compared with other paleoclimate records from northern hemisphere and other regions (both on continents and in oceans) to discuss the interhemispheric links during the last glacial. The manuscript was overall mature and well-written, but the section 5 of this manuscript is a bit hard to read, particularly for me to eyeballing Figs. 4, 6, 10, 11 at the same time. The contents and orders of these figures might be further improved.

Specific comments: L90 & L92: The setting of site is vague. It was a "overgrown crater lake" but also part of a "peat bog"?

L131 & L147: Could you explain what k-value is and how it is related to estimate sedimentation rate?

L264: if BIT is close to 1 steadily throughout the core, it does not mean any prerequisite for the valid use of brGDGTs-based proxies. BIT itself does not endorse anything considering its complexity in lake sediments. It only indicates low concentrations of crenarchaeol in the samples you analyzed. It could be that the paleo-lake is small and shallow without in-situ lake thaumarchaea community, or that the catchment soils are generally wet (Dirghangi et al., 2013).

L277-278: It is indeed possible and not surprising for lake sediments. This is why brGDGT data from adjacent catchment soils are needed to verify how much similarity in brGDGT compositions is between top sediments and adjacent soils, although the situation could be different during the last glacial and between different depositional environments (gyttja, peat, etc.). The brGDGT source is very important and could have shifts over long time scales. The TOC profile you presented suggested the lake sediments are "gyttja" over this period, but the input of soil organic matter seems still likely. If the percentage between lake OM and soil OM shifted over time, the organic geochemistry data might be tricky.

L300: Southern Annular Mode is a more popular term.

L304: Are you just using the raw proxy data as the input to run PCA? Have you standardized proxy data or logarithmized proxy data? Is it going to influence PCA results?

L386-390: It is very unclear to me. The influence of marine animals on organic matter d15N needs some reference citation. Is the signal from bird guano? Why marine bird signals are suggesting "more or less continuous of SHW"? Are winds driving upwelling and bring nutrients to harbor seabirds? Why rising d13C values are related with more "aquatic" organic carbon (many freshwater plants can have negative d13C)? How can you infer "higher influence from C4 grasses" when you have already said "after which time aquatic sources become more important"? What's the modern catchment vegetation composition?

L395: I agree with that n-alkane d2H data has good correspondence with diatom data. You may also have to think of the differential response between mid- and longchain alkane d2H. Both precipitation/source water d2H and evaporative enrichment can cause d2H shifts, but it is possible to separate these two signals by using the difference between terrestrial and aquatic plant biomarker d2H (Seki et al., 2011; Rach et al., 2014). Again, it is better to have some modern plant biomarker data at this site.

L414 & 428: You cannot use MST/MAT as a proxy for "winter temperature". Pearson et al. (2011) gave a transfer function for summer air temperature for the reason that many of their lakes have strong seasonality: only summer is biologically important and only summer temperature is monitored. Most of intact brGDGT molecules were produced during summer. Again, winter has almost nothing to do with brGDGT-producing bacteria as the whole lake is frozen and catchment is covered by snow. Loomis et al. (2012) chose mean annual air temperature because most of their lakes are from highelevation tropics with very weak seasonality: every season is biologically important. Your study site is in subtropical mid-latitude and I expect your brGDGT data will be controlled by mean annual air temperature with a bit bias towards warmer/more productive summer, but you cannot just use that ratio to represent "winter temperature". This is a misunderstanding on GDGT proxy itself.

L441, Fig. 7A: during the late Holocene simulation, the natural variability of d2H has a range of ∼10 permil. Using correspondent maximum zonal wind latitude data, you can estimate the sensitivity of precipitation d2H to westerly core belt latitude, in unit of permil/degree latitude. This might be useful for paleo-westerly reconstruction. You may also note that the range of sediment core n-alkane d2H data are much larger than ∼10 permil, indicating that (1) millennial-scale westerly latitudinal shifts have much larger amplitude than inter-annual scale of the late Holocene, and/or (2) sediment core d2H data, especially "aquatic" n-C23 have been dominated by variations in evaporative enrichment in lake water.

L432: The isotope GCM is simulating precipitation d2H variation, but not the lake water evaporation signal, although it is possible that drier conditions could cause increased raindrop re-evaporation below cloud, just like today's Nevada and Arizona, but I am not sure if raindrop process is included in isotope GCM. The higher d2H values in model might indicate increasing contribution of low latitude moisture. If the westerly moved south, the island will be close to expanding subtropical zone, leading to increasing likelihood influenced by descending and warm (less negative d2H) air masses. If the westerly moved north, the island will be close to westerly core, receiving more moisture from polar air (more negative d2H), more similar to today's 50 degree S condition.

L447: Is period of "1981-2010" within 20th century reanalysis? Should it be 1901- 2000? Is the gray lines in (B)-(D) are showing results from 20th century? Figure caption is incomplete.

L612: Why frost can be linked with weathering and CIA index?

L670: Is there any physical mechanism to explain the transition from unstable to stable climate mode? Technical corrections

L35: 4 k

L162: Xavg, avg subscript

L181: and 15N/14N

L193-194: bracket was missing