Clim. Past Discuss.,
https://doi.org/10.5194/cp-2019-158-AC2, 2020

Climate of the Past Discussions

Interactive comment on "Glacial to interglacial climate variability in the southeastern African subtropics (25–20° S)" *by* Annette Hahn et al.

Annette Hahn et al.

ahahn@marum.de

Received and published: 9 October 2020

REBUTTAL COMMENTS IN CAPITAL LETTERS

Interactive comment on "Glacial to interglacial climate variability in the southeastern African subtropics (25–20âŮę S)" by Annette Hahn et al. Anonymous Referee #2 Received and published: 24 September 2020 Based on a sediment core from Delagoa Bight offshore southeastern Africa, Hahn and co-authors present a new multi-proxy reconstruction of the continental climate for the last 100,000 years. The new record has high potential to improve our understanding how continental wetness has varied in response to latitudinal shifts in the westerlies and South Indian Ocean convergence zone. The data are certainly of very good quality and the new record has great poten-

tial, which, however, is not fully exploited in the current version of the manuscript. In my view there are several major shortcomings (see comments below) and major revisions are therefore required before the manuscript can be accepted for publication in CoP. I would like to emphasize that I will focus only on major issues at this stage of the review process: WE WOULD LIKE TO THANK THIS REVIEWER FOR THEIR CONSTRUCTIVE COMMENTS AND WE HAVE REPLIED TO EACH COMMENT INDIVIDUALLY BELOW. THE REVIEWER COMMENTS ARE IN BLACK AND OUR RESPONSES IN BLUE. âAËŸ c The study site appears to be ′ ideally situated to record displacements of the westerlies and the South Indian convergence Zone. Unfortunately, the authors do not really present a more detailed figure of the present-day atmospheric circulation patterns, which would help the readers to understand the discussion better. Basically, more detailed information on the atmospheric dynamics and according figures are required, such as the one presented by Charlotte Miller an co-authors in a previously published article in Climate of the Past (Figure 1 in Miller, C., et al. (2019). "Late Quaternary climate variability at Mfabeni peatland, eastern South Africa." Climate of the Past 15(3): 1153-1170. WE HAVE ADDED SUB FIGURES 1 B AND 1C AS WELL AS THE FOLLOWING MORE DETAILED DESCRIPTION OF THE REGIONAL ATMOSPHERIC DYNAMICS IN THE "REGIONAL SETTINGS "SECTION (LINES 114-128).:" ALTHOUGH THE ITCZ CURRENTLY DOES NOT DIRECTLY AFFECT THE REGION, IT DOES INDUCE LATITUDINAL SHIFTS IN THE SIOCZ, WHICH CAN BE CONSIDERED AS A SOUTHWARD EXTENSION OF THE ITCZ. WHEN THE ITCZ IS IN ITS SOUTHERNMOST (SUMMER) POSITION, TROPICAL TEMPERATE TROUGHS (TTTS), FORMING AT THE SIOCZ BRING EASTERLY RAINFALL FROM THE INDIAN OCEAN (JURY ET AL., 1993; REASON AND MULENGA, 1999) (FIG 1B). DURING AUSTRAL SUMMER, A LOW-PRESSURE CELL DOMINATES THE SOUTHERN AFRICAN INTERIOR, ENABLING TROPICAL EASTERLIES/TTT TO BRING RAINFALL TO THE REGION. THIS RAINFALL IS SUPPRESSED DURING AUSTRAL WINTER, WHEN A SUBTROPICAL HIGH-PRESSURE CELL IS LOCATED OVER SOUTHERN AFRICA, (FIG. 1B). THIS HIGH-PRESSURE CELL CRE-

ATES A BLOCKING EFFECT OVER THE CONTINENT, WHICH STOPS MOISTURE ADVECTION INLAND OVER THE MAJORITY OF SOUTH AFRICA DURING WINTER (DEDEKIND ET AL., 2016). THE WINTER RAIN THAT DOES FALL (33 % OF ANNUAL RAINFALL FROM APRIL TO OCTOBER) IS ASSOCIATED WITH EXTRATROPICAL CLOUD BANDS AND THUNDERSTORMS LINKED TO FRONTAL SYSTEMS THAT DEVELOP IN THE MAIN SHW FLOW (BETWEEN 40 °S AND 50 °S). AS THE SHW SHIFT NORTHWARD DURING THE WINTER, THESE FRONTAL SYSTEMS MAY BECOME CUT OFF AND DISPLACED EQUATORWARD AS FAR NORTH AS 25°S (C.F. BARAY ET AL., 2003; MASON AND JURY, 1997) (FIG 1C). " âAËŸ c Although ′ multiple proxies were measured, there is rather little and very rudimentary information on their paleoclimatic significance and potential uncertainties and limitations are not discussed. For instance, the precipitation indicators δD, K/Al, Ca/Fe and red/blue ratios are only very briefly presented in paragraph 3.1.3. All proxies depend to varying extents on precipitation, erosion and fluvial transport, whereas these factors do not necessarily vary in concert. For instance, erosion is not always directly linked to the amount of precipitation and vegetation density is often an additional and more important factor for erosion rates. Erosion rates can also increase substantially at times of rapid climatic and associated vegetation changes. Because the relationship between precipitation and erosion (and riverine transport) is not linear. I would like to see a more critical discussion about the strength and weaknesses of the proxies. DD IS INDEED OUR ONLY "REAL" PRECIPITATION INDICATOR WHEREAS THE REMAINING PROXIES REFLECT EROSION, FLUVIAL TRANSPORT AND THE WEATHERING OF THE TRANSPORTED MATERIAL. ALL OF WHICH ARE INDEED LIABLE TO HAVE A NON-LINEAR RELATIONSHIP WITH PRECIPITATION AMOUNT. HOWEVER, SEEING THAT THE FOUR PROXIES (MOSTLY) CORRELATE IN OUR RECORD, THIS DOES NOT SEEM TO BE THE CASE FOR THE MOST PART OF OUR RECORD. WE HAVE ADDED THE FOLLOWING TEXT TO THE PARAGRAPH IN QUESTION (3.1.3) LINES 317-329: "" WE ALSO NOTE THAT OF THE FOUR PROXY INDICATORS ($\triangle$DC31, RED/BLUE, K/AL AND CA/FE) ONLY $\triangle$DC31 CAN

BE CONSIDERED AS DIRECT INDICATOR OF PAST PRECIPITATION CHANGE. RED/BLUE, K/AL AND CA/FE DEPEND TO VARYING EXTENTS ON PRECIPITATION, EROSION AND FLUVIAL TRANSPORT, WHEREAS THESE FACTORS DO NOT NECESSARILY VARY IN CONCERT. FOR INSTANCE, EROSION IS NOT ALWAYS DIRECTLY LINKED TO THE AMOUNT OF PRECIPITATION AND VEGETATION DENSITY IS OFTEN AN ADDITIONAL AND MORE IMPORTANT FACTOR FOR EROSION RATES. EROSION RATES CAN ALSO INCREASE SUBSTANTIALLY AT TIMES OF RAPID CLIMATIC AND ASSOCIATED VEGETATION CHANGES. BECAUSE THE RELATIONSHIP BETWEEN PRECIPITATION, EROSION AND RIVERINE TRANSPORT IS NOT LINEAR WE BASE OUR PRECIPITATION RECONSTRUCTION (I.E. THE DEFINITION OF THE ARID AND WET INTERVALS DESCRIBED IN SECTION 3.2 AND COLORED-CODED IN FIG. 4) MAINLY ON THE $\triangle$DC31 VALUES. WE CONSIDER THE RED/BLUE , K/AL AND CA/FE VALUES AS SUPPORTIVE INFORMATION; THE RELATIVE CORRELATION OF THE FOUR PROXIES SUGGESTS THAT PHASES OF INCREASED PRECIPITATION ARE, FOR THE MOST PART, ASSOCIATED WITH AN INCREASE IN EROSION RATES, CHEMICAL WEATHERING AND RIVERINE TRANSPORT. THIS UNDERLINES THE RELIABILITY OF OUR PALEOPRECIPITATION RECONSTRUCTION. "

âAËŸ c Some ′ of the authors have worked for a long time in this region and published multiple articles on past climate variability in this region. It is therefore quite surprising that there are no attempts to incorporate other continental records from South Africa more effectively into this study. Some of the records are mentioned in the text but not displayed in a figure. WE ARE UNSURE AS TO WHICH RECORDS THE REVIEWER IS REFERRING TO. RECORDS THAT SPAN THE TIME FRAME IN QUESTION AND AT THE SAME TIME HAVE A RESOLUTION THAT IS COMPARABLE TO THAT OF CORE GEOB20616 ARE VERY RARE IN THE REGION. THE ONLY AVAILABLE RECORDS ARE LOCATED MUCH FURTHER NORTH AND THUS OUT OF THE INFLUENCE OF THE CLIMATIC SYSTEMS WE ARE DESCRIBING. âAËŸ c The major precipitation indicators are presented in Figure 4, together with ′ ice core records from

both poles. The authors try to mark wet periods associated with different atmospheric circulation regimes. However, it remains absolutely enigmatic which scientific criteria were actually used to determine these periods. The width of the color-coded bars seems to be rather arbitrary as, for instance, indicated by the width of the green bar during MIS 5, which do not really match the minima in the δD and K/Al records. The authors must explain in close detail which criteria were used to determine the different climatic phases. Furthermore, what is actually happening during the white intervals? WE HAVE DETAILED THAT THE DEFINITION OF THE DIFFERENT CLIMATIC PHASES IS MAINLY BASED ON THE DD VALUES, THIS IS OUR MOST DIRECT PRECIPITATION PROXY AND THE RED/BLUE RATIOS AS WELL AS ELEMENTAL RATIOS SERVE MAINLY AS SUPPORTIVE INFORMATION, UNDERLINING THE RELIABILITY OF OUR PALEO-RAINFALL RECONSTRUCTION. WE DEFINITELY NEEDED TO CLARIFY THIS AND HAVE ADDED THE FOLLOWING TEXT TO LINES 323-328: “LINEAR WE BASE OUR PRECIPITATION RECONSTRUCTION (I.E. THE DEFINITION OF THE ARID AND WET INTERVALS DESCRIBED IN SECTION 3.2 AND COLORED-CODED IN FIG. 4) MAINLY ON THE ΔDC31 VALUES. WE CONSIDER THE RED/BLUE , K/AL AND CA/FE VALUES AS SUPPORTIVE INFORMATION; THE RELATIVE CORRELATION OF THE FOUR PROXIES SUGGESTS THAT PHASES OF INCREASED PRECIPITATION ARE, FOR THE MOST PART, ASSOCIATED WITH AN INCREASE IN EROSION RATES, CHEMICAL WEATHERING AND RIVERINE TRANSPORT. THIS UNDERLINES THE RELIABILITY OF OUR PALEO-PRECIPITATION RECONSTRUCTION .” CONCERNING THE WHITE PHASES; THESE WE CONSIDER AS TRANSITIONAL PERIODS, AS IS NOW MARKED IN THE CAPTION OF FIG 4. âAËŸ c Figure 5 is a basic conceptual model, but it also highlights ′ the problem of this study as other records were not really used to support this basic model. WE UNDERSTAND THAT THE REVIEWER WOULD LIKE TO SEE A MORE THOROUGH COMPARISON OF OUR RECORD WITH OTHER REGIONAL CONTINENTAL RECORDS. HOWEVER, THERE ARE FEW/NONE RECORDS THAT SPAN THE TIME FRAME IN QUESTION AND AT THE SAME TIME

HAVE A RESOLUTION THAT IS COMPARABLE TO THAT OF CORE GEOB20616. THE ONLY AVAILABLE RECORDS ARE LOCATED MUCH FURTHER NORTH AND THUS OUT OF THE INFLUENCE OF THE CLIMATIC SYSTEMS WE ARE DESCRIBING. The authors suggest that the major changes on glacial interglacial time scales are related to latitudinal shifts of atmospheric boundaries and westerlies. Are there no zonal shifts in the moisture transport? THIS IS AN INTERESTING POINT; HOWEVER WE FIND NO EVIDENCE FOR ZONAL SHIFTS IN THE MOISTURE TRANSPORT. THERE IS A DIVIDE (CAB, CONGO AIR BOUNDARY) BETWEEN ATLANTIC AND INDIAN OCEAN MOISTURE BUT IT IS LOCATED VERY CLOSE TO THE ATLANTIC COAST (THE ATLANTIC MOISTURE SIMPLY DOES NOT MAKE IT TO THE INTERIOR DUE TO THE BENGUELA UPWELLING). ONLY UNDER CONDITIONS WITHOUT BENGUELA UPWELLING (I.E. BEFORE THE MIOCENE ESSENTIALLY) IT WOULD HAVE BEEN POSSIBLE THAT THE CAB WAS LOCATED FURTHER EAST AND ATLANTIC MOISTURE WOULD MAKE IT TO THE EASTERN COAST OF SA. UNDER THE MODERN CLIMATE (UPWELLING, ATMOSPHERE) SYSTEM, EVEN UNDER GLACIAL STATE, IT IS SIMPLY NOT POSSIBLE. Furthermore, I would like to see a third figure showing the conceptual model for the present-day situation. THE PRESENT DAY SITUATION WOULD CORRESPOND TO THE “INTERGLACIAL STATE”. WE HAVE MARKED THIS ACCORDINGLY IN THE CAPTIO

Please also note the supplement to this comment:
https://cp.copernicus.org/preprints/cp-2019-158/cp-2019-158-AC2-supplement.pdf

Interactive comment on Clim. Past Discuss., https://doi.org/10.5194/cp-2019-158, 2020.

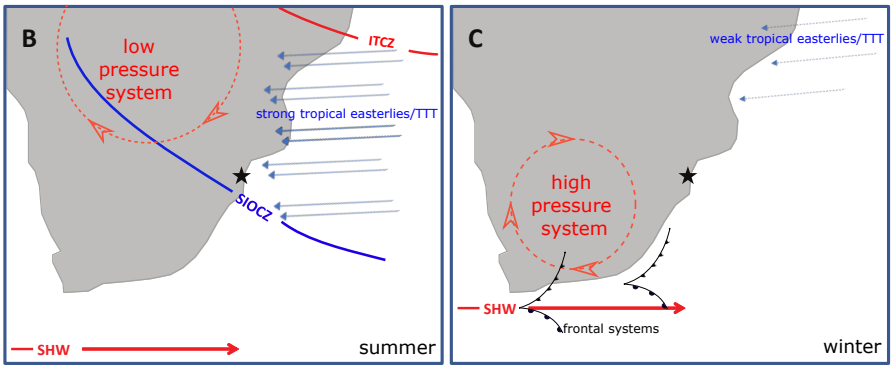

Fig. 1. revised fig 1

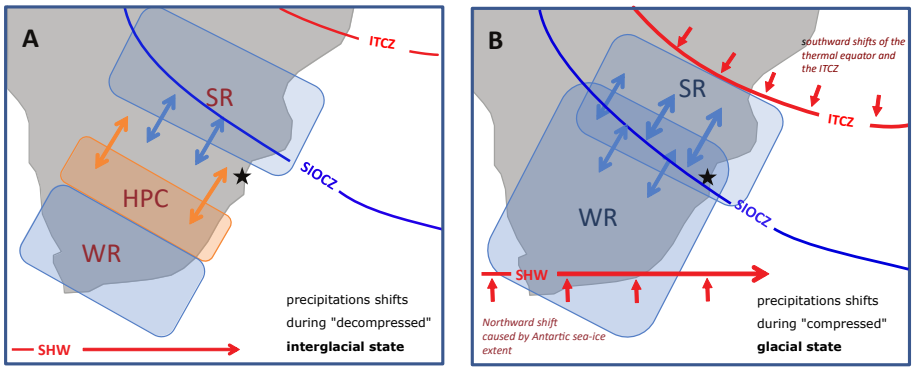

Fig. 2. revised fig 5