

Dear Referee #4,

Thank you very much for your helpful comments! Please find replies below.

Comment: 1) Chronology and resolution. While it is claimed that the records have high-resolution, this is not evident from the data. It is not clear how many samples have been analyzed, especially for core 976A and what was the resolution: 0.5, 2 cm? Further, the choice for excluding several of the data points from the final age-depth model seem to be arbitrary – the exclusion of the ages with lower precision lead to further exclusions. How would the age-depth model have been if the samples with the lower precision were kept, instead (± 10 years at 4000 cal BP does not make a big difference). Further, the choice of linear interpolation has been shown to give less reliable ages (Blaauw et al., 2018). Why not using Bayesian modeling?

Reply: The comments on the chronology and resolution are greatly acknowledged! We have added a clear statement that the sampling resolution is 0.5 cm. Moreover, we followed the suggestion and used Bayesian modelling in order to construct our age model. Thereby, we kept the double dated samples (the ones formerly excluded due to lower precision) and just neglected two dates. The exclusion of these two dates is now explained on the basis of the lithology of the sediment core, which provides no evidence for an extraordinary high accumulation interval.

Comment: 2) The “results” and “discussions” chapters should be better separated, some of the text under the later would better fit under the former.

Reply: We have shifted the comparison of our records into the “results” chapter.

Comment: 3) Their seem to be multiple issues with the “alignment” of the proxies, possibly resulting from the less precise (see above) chronology. Which of the several periods is identified precisely with the 4.2ka event? Further, given that both summer and winter temperatures are reconstructed, the discussion should be separated for the two seasons. Next, rather than assuming that the 4.2 ka event was dry in the region and try to support this by choosing one or other of the “peaks” in the data I suggest starting with multiple hypothesis and discuss them in light of your data. Several studies in the wider study region have shown that the 4.2 ka BP event could have been wet (e.g., Zielhofer et al., 2018) during winter.

Reply: For the “alignment” of the proxies we now used statistical methods (Pearson’s correlation coefficient) to underline our interpretation. Also following Referee #1, we have emphasized the discussion on the 4.2 ka event. Thereby, we followed the suggestion of Referee #4 and started with multiple hypothesis. Furthermore, to improve the readability we divided the discussion on the SSTs for summer and winter season also following a comment from Referee #1.

Comment: 4) The mechanisms described in chapter 4.2 (“Possible drivers...”) rely more on Ausin et al. (2015) than on the data from the power. See also the comment above and the detailed comments below and try to improve the interpretation by providing a mechanistic evidence for the described processes.

Reply: We increased the discussion on the driving mechanisms also providing more detailed ideas on how they work and can affect our data.

Comment: P1, L23: Dansgaard et al (1993) is outdated, perhaps some newer and better references would be better

Reply: We replaced Dansgaard et al. (1993) by Rasmussen et al. (2014).

Comment: P2, L2: numerous other events are not resolved in NGRIP...

Reply: We have deleted this reference.

Comment: P2, L12-13. I am not an archaeologist/historian, but perhaps “turnover” is not the best word to be used in this context

Reply: This part of the introduction has been deleted. Following Referee #3 we wanted to minimize the focus on the 4.2 ka event in the introduction. The introduction now focusses just on the climate and the mechanisms considered as possible driver.

Comment: P2, L20. Please detail the contrast

Reply: We added some examples for this contrast.

Comment: P3. The word “relatively” is overused in the chapter 1.1. While Iberia is relatively cool (L2) compared to N Africa, is relatively hot, compared to N Canada. Please give the values for the temperature, it would allow readers to better understand the present-day climatic conditions.

Reply: We added modern values for temperatures discussed in this chapter.

Comment: P3, L7 you mean mm instead of ml

Reply: We have corrected this.

Comment: P3, L15: please detail the circulation, separately for the season, it is not clear from the text (e.g., you discuss low SST in the Atlantic margin and then jump to warm inflow to the Alboran Sea...)

Reply: We added a detailed discussion on the ocean circulation also separated for summer and winter season. The oceanic currents and circulation pathways have also been drawn into Figure 1.

Comment: Materials and methods: please improve the description of the sampling strategy, it is not clear what resolution you achieved in the end. Age model: see the comments above, the choices need to be better explained. A critical discussion on how a different choice of exclusions would have affected the results would be welcomed.

Reply: We re-wrote these chapters (see reply above).

Comment: P6, l1: ccm is cm³?

Reply: Yes, it should be. We have adjusted it.

Comment: P6, proxy reconstructions. Please give values for the Q for both rivers, as well as for the seasonal discharges to better understand the seasonality of alkanes in the cores

Reply: We added seasonal discharge data for the Guadalquivir into the “study area” section. Unfortunately, we did not find such data for any rivers draining the southern Sierra Nevada. All we found were very recent data, which are affected by river dams and, thus, show a very different anthropogenic signal.

Comment: P7, results: please add “cal” after ka (e.g., 4.3 ka cal BP)

Reply: We have adjusted this for the whole manuscript.

Comment: P7, L11: the contemporaneity should be discussed in the light of chronological issues; P7 and 8, results: the entire chapter is somewhat confusing, please try to simplify it. Also, it is not clear how the various dry/cold/warm periods have been found to be contemporaneous.

Reply: We re-structured the “results”-chapter and separated it for both sediment cores – each with a clear separation of terrestrial and oceanic proxy results. Afterwards, we added a sub-chapter

comparing the data of both sediment cores using also statistical approaches (see reply above) and also discussing chronological issues.

Comment: P8, l19: was it dry in winter or summer? See the detailed comment above

Reply: It was most likely dry in winter since our n-alkane proxy is probably biased towards the winter season. But, we have added this also in the discussion when discussing our n-alkane data.

Comment: P9, L11: 20 years..what is the age error here?

Reply: We deleted every second decimal within the ages. Also, according to the new age model this period is now longer. Furthermore, we gave the age uncertainty for every dry event observed in our study.

Comment: P9, L15: winter or summer, again? Generally (I repeat myself) the discussion should be clearly separated for summer and winter

Reply: We agree that this was confusing and difficult to read. We re-structured the discussion chapter into terrestrial and marine sub-chapters and, further, discussed the seasonal SST variations separately.

Comment: P9, L25-26: not clear, the cooling trend would result in colder, not warmer SSTs

Reply: We meant that over the Holocene SSTs are generally cooling (due to decreasing insolation) with lowest mean SSTs during more recent times. Consequently, it is reasonable that the SST in the Mid- Holocene was warmer compared to today. We have restructured this sentence in order to make this clearer.

Comment: P9, L25: "at that time" What time?

Reply: We replaced "at that time" with "during the studied period".

Comment: P9, L29 and next lines on P10: for which period are these temperatures given?

Reply: The temperatures mentioned all focus on the studied period between 2.9 and 5.4 ka BP. We have added a clarification in this part.

Comment: P10, L9: hm, the resolution problem. Was it high or low? My quick calculations show that the resolution is closer to 100 years at the time of interest....

Reply: We included the resolution of the "low resolution" studies from the area for better comparison.

Comment: P10, l15-19: for which period does this paragraph refer to?

Reply: For the whole analysed period. We added a statement to make this clear.

Comment: Generally, chapter 4.1 is a mix of results and discussion, most of it should go under "results"

Reply: We have adjusted this (see also reply above).

Comment: P10, chapter 4.2.. This is the "meat" of the paper, but the discussion is quite weak. I also think that "NAO-like variability" is quite over abused. Further, if the ANO is to be used, perhaps it would be more useful to use a NAO reconstruction, rather than a storminess one, which could result from other factors than NAO (e.g., Olsen et al., 2012)

Reply: We emphasized the discussion on the possible drivers. We also followed the suggestion by Referee #4 and now refer to the NAO reconstruction from Olsen et al. (2012). We, intentionally chose the Goslin et al. (2018) data because it covers the whole time period of our study.

Comment: P11, L15: the comparison with the IRD record is useful as long as the mechanisms linking the two are better described. Else, correlation and causality are different. Please improve the discussion by including mechanistic explanation that could result in the variability described here.

Reply: We introduced the Bond Events and associated changes broadly in the introduction and, further, improved the discussion on the mechanisms in the light of our data.