Reply to reviewer William Fletcher

We thank Dr William Fletcher for his time and effort to review our manuscript and for his highly helpful comments and encouragement. Dr W. Fletcher has three general comments and seven specific points which we will all consider in our revision of the text. Below we answer to comments raised by the reviewer (in blue), and more details will be integrated into the revised version.

General points

1) I wonder if the authors have considered using a Bayesian approach to the age-model construction (seeing that the free online software OxCal was already used here for working with the 210Pb ages)? It would be really nice to present both the ages and uncertainties for the CR and high-TERR episodes, for example, and it would represent a valuable contribution to the literature concerning rapid Holocene changes in the Mediterranean.

Reply: Following this suggestion, we used the Bayesian approach of the OxCal 4.2 software to determine the uncertainties of CRs and HTE (High TERR-alkane episodes) ages. We used the CQL code defined by Ramsey et al. (2013) to reconstruct the deposition model and to determine the age uncertainties. Both ages and uncertainties of CRs and HTE were represented in new tables (Table 2 and 3 in revised version).

2) As a general point, it would be interesting to see more discussion of the value of studying the two proxies in parallel, as shown in Figure 2. In general, the treatment of the two proxies is quite strongly separated (both in terms of discussion sections, and figures). It might be worthwhile to show the CRs and high terrestrial input phases on the same figure (for example in Figure 2) to allow the reader to visualize similarities between the two types of interval discussed in the paper - currently the high TERR phases are only shown in Figure 4 without the SSTs. Overall, the extent to which the two proxies are mutually beneficial/complementary could be discussed more explicitly.

Reply: In revised Fig. 2, we now plot the CRs and HTE together. The comparison shows that HTE sometimes match but not always. In the discussion section (4.3 in revised version) we note that HTE start to occur at the onset of SST cooling and show CRs even though we cannot accurately attribute HTE to cold SSTs. This variability has been linked to the Alpine glacier dynamics (Schimmelpfennig et al., 2012).

3) As a third general point, I note that the paper does not use (or only very rarely) the term "centennial-scale", favouring "multi-decadal". While many of the insights gained from present climatology do relate to multi-decadal or higher frequency modes of variability, the episodes highlighted by grey or brown bars (CRs and high TERR input phases) are of multi-centennial-scale, as are some of the named historical climate intervals (e.g. Dark Ages, Medieval Climate Anomaly). Without detracting from the substantially sub-centennial-scale of the sampling resolution, I feel that the authors should consider using the term "centennial-scale" where appropriate. Not only does this seem more accurate for the episodes in question, but also highlights (at least implicitly) the recognition that there still remains a gap in timescale

between documented annual to multi-decadal modes of variability (NAO, EA, AMV, etc) and Holocene events on longer Holocene timescales.

Reply: We agree with the reviewer that the term "centennial-scale" should be used mainly in regard to the CRs and HTE. We modified the text following this remark.

Specific comments

1) Section 4.1 - There is a mismatch in the description of "three main phases" during the Holocene (P3193). The authors describe (1) a warm early Holocene, (2) cooling interval, and (3) last century warming. These do not map onto the Preboreal, Hypsithermal and Neoglacial as stated, but rather (1) the Hypsithermal, (2) Neoglacial, and (3) last century. The authors should correct this and any inferences derived from this correlation. In fact, there is not much discussion of the Preboreal, although this interval is apparent, for example, in many of the records shown in Figure 3.

Reply: We agree with the reviewer and the similar remark of the other reviewer. We now refer broadly to early, mid and late Holocene.

2) Section 4.2 - The authors should specify the ages (and ideally also the age uncertainty, duration and amplitude) of the "Six CRs of different duration and amplitude" in P3194 Line 9 or in an accompanying table. This can aid future comparison between records.

Reply: Correct. Showed in new Table 2.

3) Section 4.2, Page 3195, line 19. "It is notable that M8 does not show much cooling in our record..." Unless I missed something, the authors have not indicated the "M-events" in core MD99-2343, and need to label (e.g. in Figure 2) or define them for the reader to be able to follow this statement.

Reply: The M-events were added to revised Figure 2 and indicated by arrows no. M0 to M8. The M events or "Minorca events" are abrupt events defined by Frigola et al. (2007) in the Minorca sediment drift. According to Frigola et al. (2007), these centennial- to millennial-scale events provide a proxy of deep-water formation in the Gulf of Lions.

4) Section 5, P3197, Line 19. The authors note that lack of impact of the 8.2 ka event, but might also mention other events for which terrestrial impacts have been detected in the western Mediterranean region, e.g. 9.3 ka event, Preboreal oscillations, etc. (e.g. Nebout et al., 2009; Fletcher et al., 2010). Overall, while the authors report the absence of an expected 8.2 event, the paper could go further in terms of developing the explanation for why conditions at the site location would not have been sensitive to this event, or other early Holocene fluctuations. Can other factors than the LIW formation hypothesis be explored, for example seasonal (summer vs winter) biases in the proxies?

Reply: In the revised version of the manuscript we now outline the mismatch between the Gulf of Lions SST record and the M events, in particular M7 and M8. We also highlight that Frigola et al (2007) already reported a mismatch between M events and the d18O on G.

bulloides. We finaly make the point that SSTs from the Alboran Sea (Ausin et al., 2015) do not match either with M events, and even though the authors report some degree of resemblance with the hexacosanol index, reflecting the oxidation state of organic matter as a proxy of ventilation, alkenone SSTs do not even record any cooling event (CR). Lines 220-234.

5) Figure 3. I would recommend for clarity that the labels relating to the long-term warming or cooling amplitude be moved to the side of the figure, to avoid confusion with the grey bars showing the CRs.

Reply: Modified in revised Fig. 3.

6) Figures 2, 3, 4. Give axis label for the upper x-axes, also.

Reply: Modified in revised Figures.

7) Language corrections - to aid the authors in preparing a revised version, I note the following necessary corrections (this may not be an exhaustive list): P3189, Line 11. Change "the alkenones" to "alkenones" Section 2 Change "Materiel" to "Material" P3190, Line 12. Change "storm tracks position" to "position of the storm tracks" P3192, Line 16. Change "were colder" to "colder", "superimposed to" to "superimposed on" P3194, Line 22. Change "cooling" to "coolings" P3196, Line 6. Change "precipitations occur" to "precipitation occurs".

Reply: We thank Dr Fletcher for English corrections that help improving the manuscript as well as his constructive comments.

References:

Ausín, B., Flores, J. A., Sierro, F. J., Cacho, I., Hernández-Almeida, I., Martrat, B., and Grimalt, J. O.: Atmospheric patterns driving Holocene productivity in the Alboran Sea (Western Mediterranean): a multiproxy approach, The Holocene, 25, 1–13, doi:10.1177/0959683614565952, 2015.

Frigola, J., Moreno, A., Cacho, I., Sierro, F. J., Flores, J. A., Grimalt, J. O., Hodell, D. A., and Curtis, J. H.: Holocene climate variability in the western Mediterranean region from a deepwater sediment record, Paleoceanography, 22, PA2209, doi:10.1029/2006PA001307, 2007.

Ramsey, C.-B. and Lee, S.: Recent and planned developments of the program OxCal, Radiocarbon, 55, 720–730, 2013.

Schimmelpfennig, I., Schaefer, J.-M., Akçar, N., Ivy-Ochs, S., Finkel, R.-C., and Schlüchter, C.: Holocene glacier culminations in the Western Alps and their hemispheric relevance, Geology, 40, 891–894, 2012.