

Reply to Reviewer #1

At first, we would like to thank reviewer #1 for his highly helpful comments and we are grateful for his time, efforts, and suggestions. Reviewer #1 has a major comments bear mostly on interpretation/discussion and he addressed some minor issues. Below we answer to comments evoked by the reviewer point by point (in blue), and more details will be integrated into the revised version.

1) The authors describe in relatively detail the study area and mention some of the currents, water masses, Mistral and Tramontana winds, and geographical locations in the Western Mediterranean in section 2.1. These should be included in Figure 1, at least those that are essential for the discussion (e.g. Gulf of Lions).

Reply: We added Mistral, Tramontana, Bora and Vardar winds to figure 1, the main winds blowing in the Mediterranean Sea. We also added the geographical locations of the three deep-water formation areas on the map (Gulf of Lions, Adriatic Sea and Aegean Sea).

2) I find the paper is well organized and has an easy-to-follow structure. However, I suggest to combine the “oceanographic setting” with the introduction or to create a specific section for it between “introduction” and “material and methods”. Similarly, I think P. 3196, lines 4-13 would fit better in the introduction section.

Reply: The introduction of the revised version of the manuscript now provides a more detailed description of the oceanographic setting and rainfall regimes.

3) The authors assume that the reader must know many of the processes occurring in the Western Mediterranean basin. I believe slightly more detailed explanation of some statements would make the paper easier to follow, especially by those not familiar with the study area. An example:

-P. 3190, lines 8-10 mention the influence of LIW in deep water formation processes. This explanation is very brief and might be insufficient for a general reader to understand the subsequent discussion. The authors should explain how these contents of “heat and salt” are in comparison with those of the upper water masses and in which way these properties of LIW influence deep water formation in the Gulf of Lions.

Reply: the introduction of the revised manuscript provides a thorough description of the role of the LIW in the open-sea convection process: during winter, dry and cold winds triggers vertical mixing. As the mixed layer deepens and reaches the underlying LIW, density increases and induces convection (Schroeder et al., 2010). Dense-water formation over the shelf upon cascading to deeper layers contributes to the process (Béthoux et al., 2002).

In addition, some references are needed for some of the statements written on the text:

-P. 3189, line 1: “Because of strong ocean/atmospheric interactions in the Mediterranean region” (citation).

Reply: We added Josey et al., (2011) as a reference on atmospheric forcing as this paper provides important information on the links between the major mode of atmospheric variability and heat budget of the Mediterranean Sea that is important to the paper discussion. However, this section has been extensively re-written.

- P. 3194, line 20: "...the 8200 yr BP" (citation).

Reply: Added to the text (Johnsen et al., 2001).

-P. 3195, line 25: "...in the Eastern Mediterranean was much reduced or shutdown..." (citation).

Reply: The paragraph containing this sentence was removed.

-P. 3197, line 5-6: "Under such conditions storminess is enhanced in the Mediterranean" (citation).

Reply: Added to the text (Trigo et al. 2000)

4) -P. 3194: SST trends would be easier to see if the authors marked them with arrows in the graph. Some trends are clear (e.g. core M40/4-SL78), but other records lack such trend (e.g. core MD 90-917, M25/4-KL11, GeoB 7702-3-TEX86). If "trends" were calculated as the difference among the SST values at the lower and upper extremes of the period 7,000-1,000 yr, a positive (i.e. cold) or a negative (i.e. warm) result will be always obtained. But this does not imply the presence of a cooling or warming "trend" over this period, only that SST was colder or warmer at 1,000 yr in comparison with SST at 7,000 yr. The authors should revise this part, and in any case explain in the text how these trends are calculated.

Reply: Trends were calculated by linear regression of SST values between 7000 and 1000 yr BP. A positive trend indicates warming while a negative one points to cooling. Trends are marked by arrows in the revised Figure 3. In the revised version of the manuscript we also provide the presumably explanation for these trends, i.e. weakening of the NAO from early to late Holocene. Lines 186-190.

- I agree with the authors that there are differences among the SST patterns of the eastern and western basins. This is a current feature inherent to the Mediterranean Sea where these two basins, despite of being connected, represent very different environments. I feel the discussion of this part is more a description than an interpretation of the compared data. It should be discussed, for example, when these patterns became different between basins and to discuss why if possible.

Reply: The revised version of the manuscript now explains the spatial coherency of the SST pattern across our study regions by a weakening of NAO as suggested by Rimbu et al. 2003, which according to model data will be due to insolation changes. Lines 186-190.

5) P. 3195, line 19: please explain in the text what M events are when you talk about M8.

Reply: The M events or "Minorca events" are abrupt events defined by Frigola et al. (2007) in the Minorca sediment drift. The M events are also added to Fig. 2 and represented by arrows. According to Frigola et al. (2007), these centennial- to millennial-scale events provide a proxy of deep-water formation in the Gulf of Lions. Lines 213- 216.

6) Page 3195, lines 25-28: I am not convinced by the following author's reasoning "...we speculate that lower amounts of LIW formation during the AHP could have decreased advection of salt in the Gulf of Lions thereby contributing to weaken convection..." "...and caused a reduction of the thermohaline circulation in the Mediterranean Sea during this time period", because the UP10 by Frigola et al. (2007) does show the clearest reinforcement of deep water convection during this period over the Holocene. The authors should explain the mismatch between SST and deep water convection during M8 by a different mechanism that includes what both proxies show: warmer SST and stronger deep water convection at that time.

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 $\delta^{18}O$ on *G. bulloides*. We finally 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.

-P. 3196, line 17-19: please mark these lowest values with arrows in the graph to help the reader.

Reply: this statement here refers to mean levels not events. Rephrased in the revised version. Lines 238-241.

7) P. 3196-3197: "Comparison of TERR-alkane and flood activity in the N-Alps with NAO (Fig. 4d) indicates that high values occur during positive NAO". The NAO index shows several oscillations, mostly to a positive-NAO mode. However, almost all the negative-NAO periods also occur within those of higher values of TERR-alkanes (Fig. 4). I do not see this correspondence between TERR-alkanes and any of the two phases of NAO because periods of higher TERR-alkanes agrees with both negative and positive modes of NAO. Therefore, I do not believe any cause-effect relationship among them can be concluded (lines 22-24). On the contrary, correspondence between intense flood of the S-Alps and negative-NAO is more clear and certainly interesting.

Reply: This section has been extensively revised- section 4.3. However, given the accuracy of the age model we can hardly individual peaks, so we keep our discussion at a rather general level of comparison.

- P. 3196-3197, line 9: please check the number of the figure.

Reply: Modified in the text.

-The authors should check spelling. Some examples: P. 3189, line 16 (material), P. 3190, line 15 (is), P. 3193, line 21 (bulloides), P. 3193, line 22 (Castañeda).

Reply: Modified in the text.

Minor issues:

P. 3188, line 15: significance of “NAO”

Reply: Modified in the text.

P. 3190, lines 7: ...the “cooling and evaporation” of...(surface waters?).

Reply: Yes. Added to the sentence in the text.

Also, I don't think “spread to the bottom floor” is the proper term in oceanographic terms. I would suggest the use of “sink”.

Reply: Correct. Modified in the text.

P. 3191, line 5: the MARINE13 calibration set includes the global reservoir effect, but the authors should add this on the text, and clarify that R is the local reservoir effect.

Reply: Correct. We added in the revised version of the manuscript that the global reservoir effect is included in the MARINE13 calibration dataset and that we used a local marine reservoir age correction of $R = 23 \pm 71$ year.

P. 3191, line 20: please mention how many samples were used for the analyses and/or the obtained temporal resolution.

Reply: Modified in the text.

-P. 3192, line 11 onwards: please refer, if any, according to which stratigraphic terminology you name the “Early” and “Late” Holocene (e.g. (Walker et al., 2012) or specify the time spans. This should be also added to the graphs.

Reply: We specified an Early–Middle Holocene Boundary at 7000 yr BP and a Middle-Late Holocene Boundary at 4200 yr BP (indicated in the text). This Holocene terminology was also added to Figures.

P. 3192, line 19: figures should be explained in order. The authors name figure 2c in the text before figure 2b. Please change the order in the text or in the graph.

Reply: We changed the order in revised Fig. 2.

P. 3192, line 23: “during the second half of the Holocene”. This description is ambiguous since it depends on how the reader looks at the graph. Please clarify the time span you are referring to.

Reply: Modified in the text.

P. 3195, line 1: please use “temperature” instead of T

Reply: Modified in the text.

P. 3195, line 11: it would be helpful if the authors plot in Fig. 2b age control points used by Frigola et al. (2007).

Reply: Added to Fig. 2c.

References:

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