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Interactive comment on "Sea surface temperature variability in the central-western Mediterranean Sea during the last 2700 years: a multi-proxy and multi-record approach" *by* M. Cisneros et al.

M. Cisneros et al.

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We would like to thank the reviewer for the comments and corrections that help us to improve our manuscript. We are in agreement with almost all the suggestions and thus, they will be taken into account in the revised version. We provide the reviewer's comments in bold text and our answers below.

P. 5449 THERE ARE SEVERAL POTENTIAL ANALYTICAL ISSUES HERE. IN PARTICULAR, CORRELATIONS BETWEEN Mg/Ca AND Al NEED TO BE CAREFULLY ASSESSED FOR SIGNIFICANCE (I.E., P VALUE) RATHER THAN JUST REJECTED BASED ON THE R VALUE. IF THE CORRELATIONS ARE SIGNIFICANT, THEN

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THAT INDICATES THAT THERE IS SOME DETRITAL CONTRIBUTION TO Mg/Ca (BARKER ET AL, 2003; LEA ET AL, 2005).

-We have re-examined the correlations of Mg/Ca with Al and also Mn and we recognise that we did probably underestimate the potential interference of some contamination phases since ratios measured in cores MIN1, MR3.1B and MR3.3 presented significant correlations. In order to minimize the risk of Mg/Ca-SST overestimations due to detrital/diagenetic contamination, a rejection criteria was established, discarding those samples presenting Mn/Ca ratios above 0.5 mmmol mol-1 in core MR3.1B although in cores MIN1 and MR3.3 the threshold was relaxed to those ratios above >1 mmmol mol-1. The reason for this criteria relaxation was the absence of significant correlation (r < 0.28, p-value=0.06) after its application. We considered that this was a good compromise to minimize contamination risks without a significant lost of sample resolution. In the case of Al/Ca ratios, after the removal of the two highest Mg/Ca values in core MR3.1B and those that more contributed to the significance in core MIN1 (9 values), obtained correlations were not significant (r < 0.29, p-value=0.06). This information has been incorporated in the manuscript (Section 3.5).

Consequently, the Mg/Ca-SST anomaly stack is now different, as can be observed in Figure S2, but does not introduce significant changes in the main patterns and structures and therefore, neither in the discussion already published during the open Discussion process (Figure S2). Some minor modifications will need to be included in the final text (i.e. quantification of SST changes) and the figures but they wont involve significant variations.

*P. 5549 THE CHOICE OF THE SHACKLETON 1974 PALEOTEMP EQUATION IS AN ODD ONE, BECAUSE THIS EQUATION WAS DEVELOPED FOR BENTHIC FF. SOME BULLOIDES-SPECIFIC EQUATIONS SUCH AS BEMIS ET AL., 1998 HAVE BEEN DEVELOPED. THE AUTHORS SHOULD TRY THESE OR OTHERS, AS APPROPRIATE, AND JUSTIFY THEIR FINAL CHOICE.

-We do not consider that this is an odd choice since it is the most used equation in similar estimations, nevertheless, referee is very right pointing out that it was developed in base to benthic foraminifera but, it actually confirmed the relation-ship with inorganic calcite precipitation (Epstein et al., 1953) suggesting very little or null biologic effect in this case. Nevertheless we agree with the referee that more recent studies carried on cultured planktonic species have shown that, although the slope is rather constant, the intercepts of the equation may present differences to some degree depending on the species and also on its size range (Bemis et al., 1998). Following this referee suggestion, we have recalculate the $\delta18Osw$ values from the core top samples (Table S2, Supplementary Information) using the regression equations published for culture-derived Globigerina bulloides (11-chambered shell equation in Bemis et al., 1998) and those resulting from plankton-town G. bulloides collection (Mulitza et al., 2003). The obtained $\delta18Osw$ values (2.2-1.8 ‰ are higher than those ($\sim$1.2 ‰ published by (Pierre 1999) based in water measurements from the central-western Mediterranean Sea. In contrast, those values previously estimated with the empirical Shackleton (1974) paleotemperature equation provide $\delta18Osw$ values of 1.3 ‰ and consequently closer to the present day water values. In base to this result we have decided to stay better with our original estimate. Several factors may account for this different results but in front of the absence of specific experiments using Mediterranean species let us to consider that the more conservative approach using the general equation is probably the one more appropriate in this case. A comment on this has been added in Section 3.5.

P. 5454-55 THE ALIGNMENT OF THE DIFFERENT CORES VIA BOTH MG/CA AND MN APPEARS SOMEWHAT ARBITRARY; E.G., THE PEAKS IN FIG. 5-6 COULD BE ALIGNED IN A NUMBER OF DIFFERENT WAYS. I UNDERSTAND THAT THE AUTHORS ARE ATTEMPTING TO DEVELOP THE BEST OVERALL CHRONOLOGY FOR THEIR RECORDS, BUT SOME ADDED DISCUSSION ABOUT UNCERTAINTIES IN THIS CONTEXT WOULD BE WELCOME. FOR EXAMPLE, HOW LARGE IS THE EFFECT ON THE FINAL STACKS OF THE PROPOSED ALIGNMENTS?

We agree in that alignments could be regarded to some extend arbitrary but, this is the reason why a special care has been done in performing the Bayesian age models to make sure that any alignment was performed within the uncertainty range of the statistical models. In this way we have always kept an objective criterion limiting our arbitrariety selecting structures to align. It has to been kept in main that all cores have some absolute age indicator (14C, biostratigraphy, Pb or Cs) that anchor the records in some points (within their uncertainties) limiting the potential arbitraries in the alignments. There is only one exception to this, core MR3.1B for which any absolute age indicator exists, but this section corresponds to the second half from core MR3.1A and thus little uncertainties in the alignment of these two sections exist. It also probably worth to mention that and independent proof for our alignments was the comparison of the alignment on the grain-size record of the same cores. This information was removed for this manuscript because it was already too dense of data and it is the matter of an independent manuscript. But the coherence of the independent grain-size records after the alignment base in independent records give to as an independent objective argument to be convinced about the coherent alignment choice. Nevertheless, taking in consideration the referee doubts we have perform an exercise of producing a different stack taking only the records with the Bayesian age model and before performing any alignment between them (Figure S3). The major trends does not differ between the two stacks neither the age of the main structures, the main difference is the appearance of enhanced climate variability along the Medieval Climate Anomaly, but looking to the records that is not reflected by any of them and it results as an artefact of the lack of alignment of some of the minor structures, for this reason we believe that the proposed stacks are the best expression of the analysed records, they average a total of five records providing a record of the most robust trends and oscillations.

P. 5457: THE INFERENCE THAT G. bulloides REPRESENTS SPRING TEMPERATURES WILL BE HEAVILY INFLUENCED BY THE CHOICE OF CALIBRATION EQUATIONS FOR O18 (SEE ABOVE). HOW WOULD THIS INFERENCE CHANGE WITH A DIFFERENT CALIBRATION CHOICE?

-When the G. bulloides specific equations (Bemis et al., 1998; Mulitza et al., 2003) are applied to estimate the isotopic temperatures of core top samples the values are about 0.6°C colder or 1°C warmer, respectively, than those obtained with the Shackleton's equation. Therefore, the resulting temperatures would still be within the present spring conditions but as is argued above we have some solid arguments to use the Shackleton's equation.

ALONG THE SAME LINES, HOW DOES THE DERIVED MG/CA CALIBRATION EQUATION COMPARE TO PREVIOUS ONES? DOES IT AGREE WITHIN UNCERTAINTIES?

-Several different temperature calibrations exist for G. bulloides-Mg/Ca ratios and they provide very different results when they are applied to our data (Table S3, Supplementary Information) and the differences are far above within the uncertainties, the larger difference is above 13°C. The manuscript does no pretend to make an analysis of the reason for this big calibration differences, obviously the approaches are very different and also the source region for the calibrated specimens. For that reason it makes a big difference the chosen calibration and we believe that the fact that, the used calibration is based on a previous published one reviewed after the addition of new data points covering the temperature range of our region, is a solid argument to support our choice.

P. 5461, DIFFERENCE BETWEEN UK37' AND Mg/Ca THIS DIFFERENCE WILL ALSO BE SENSITIVE TO THE CALIBRATION CHOICE FOR BULLOIDES O18. WHAT DO THE UNCERTAINTIES REPRESENT? DO THE ABSOLUTE VALUES BETWEEN THE TWO TEMPERATURE PROXIES DIFFER ACCORDING TO A T-TEST?

-As it has been argued above, we believe that we have solid arguments to justify our choice for the G. bulloides δ18O temperature equation and consequently, we are confident that this provides the values which better represent the local oceanographic conditions. As it is described above, other choices of δ18O equations applied in the calibra-

tion would provide slightly different values but this still won't account for the described differences between the Uk'37 and Mg/Ca records, which not only differ in the actual values but also in the intensity of the SST variability and short term oscillations.

The SST uncertainties in the section 5.5 represent 1σ (standard deviation). This is indicated now on the text.

Regarding the proposed t-test: the Mg/Ca-SST and Alk-SST absolute values show a significant correlation (r=0.5; p-value=0) but results obtained by means of Welch's test indicate that the null hypothesis (means are equal) can be discarded at he 5% error level: tobserved (12.446)>tcritical (1.971).

P. 5462 (LINES 20-23): (IN REFERENCE TO THE Mg/Ca-SST AND UK37-SST COMPARISON) IT MIGHT ALSO REPRESENT INADEQUACIES IN THE DATA TREATMENT AND CHRONOLOGY. I SUGGEST THE AUTHORS CONSIDER MULTIPLE HYPOTHESES TO EXPLAIN THIS DIFFERENCE.

-As described above, Mg/Ca data treatment has already been reviewed, following referee 2 suggestions, and the resulting data from this new treatment does not introduce any significant change in the discussed differences between the two different proxy stacks, supporting that these discrepancies are real and not artefacts from data treatment.

Regarding the potential artefact resulting form the use of inadequate chronologies, our confidence in the chosen chronologies has already been argued above and their uncertainties better expressed in table S1 (Supplementary Information). But this factor can really be ignored in the case of this proxy inter-comparison since it is based in exactly the same cores whose chronology has been performed in this manuscript. Any change in the chronology would affect in the same way both proxy records and consequently won't affect the discussed apparent anti-phase in some of the structures.

SECTION 6.1: THROUGHOUT THIS SECTION, ALL TEMPERATURE CHANGES

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SHOULD BE GIVEN WITH ATTENDANT UNCERTAINTIES, IN PART TO MAKE CLEAR HOW SIGNIFICANT THE CHANGES ARE.

-The corresponding temperature uncertainties will be included in all the text. Explanations about the type of uncertainty will be shown in the beginning of the corresponding section or after the uncertainty.

SECTION 6.2: MCGREGOR ET AL., 2015, NG, CALLED ON VOLCANISM AS THE MAIN CAUSE OF THE COOLING TREND OF THE LAST 1000 YEARS. HOW DOES THIS FORCING POTENTIALLY INFLUENCE THE MED. RECORDS? COULD IT ALSO PLAY A ROLE IN DRIVING CENTENNIAL-SCALE VARIABILITY?

-No significant correlations have been obtained between Mg/Ca-SST or Alk-SST shown in this study and volcanism in Northern Hemisphere (Gao et al., 2008), but the higher volcanism in the last millennia could have acted as forcing in the general cooling trend observed in this study, given the derived induction of a net negative radiative forcing as described in McGregor et al. (2015). As is discussed in the text, several factors in addition to the summer insolation should account to explain the centennial-scale variability of the records, some of them are discussed and the potential impact of enhanced volcanism in the last millennia is now also been introduced in the discussion (Section 6.2).

Please also note the supplement to this comment:
http://www.clim-past-discuss.net/11/C3217/2016/cpd-11-C3217-2016-supplement.pdf

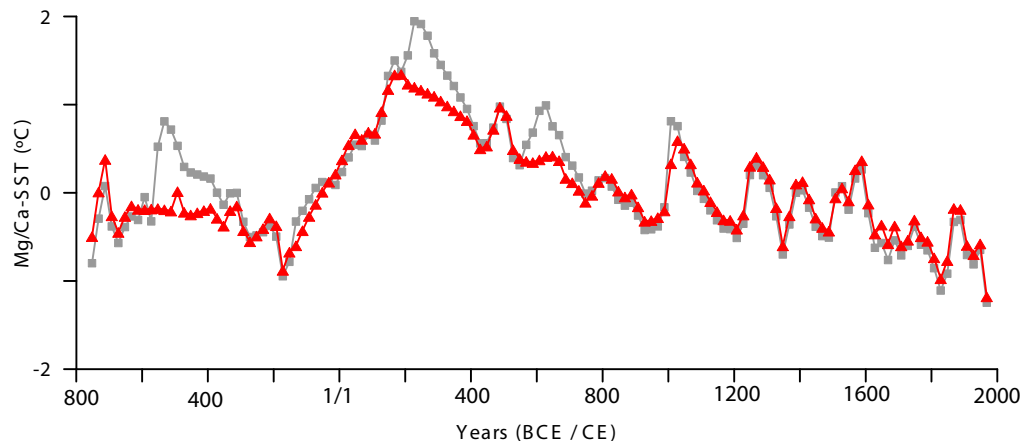Interactive comment on Clim. Past Discuss., 11, 5439, 2015.

Fig. 1. Fig. S2: Comparison of Mg/Ca-SST stacks published during Open Discussion (grey squares) and after removing with potential contamination problems on trace element data treatment (red triangles).
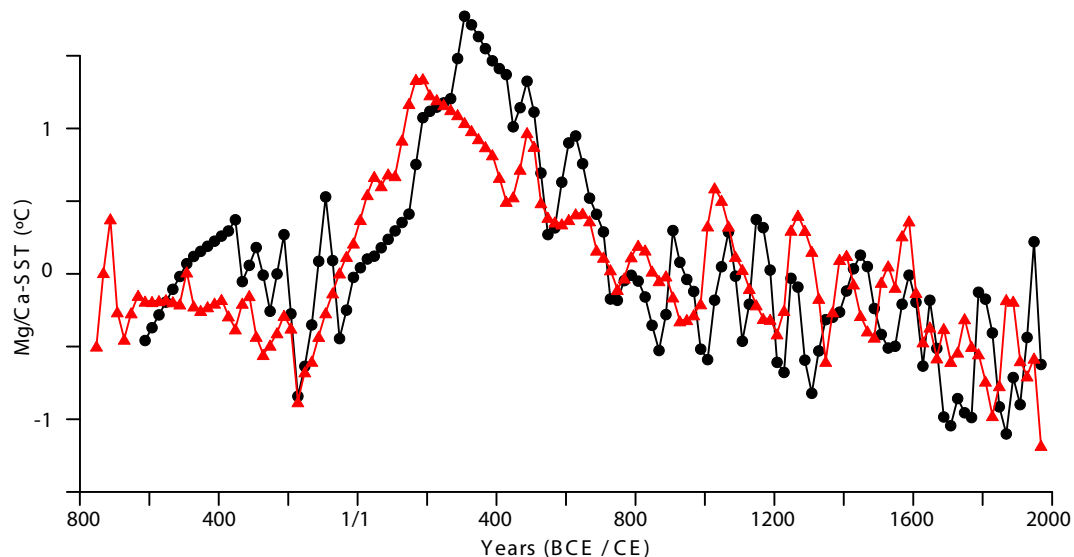
Fig. 2. Fig. S3: Comparison of the Mg/Ca-SST stack with the final age-model (red triangles) with the stack taking only the records with the Bayesian age model (cores MIN1, MIN2 and MR3.3, which have absolute