

### *Author's responses to the Reviewer 2*

We acknowledge the positive and constructive criticisms made by the reviewer 2 which helped to improve this manuscript. As detailed in the following pages, we agree with all the main suggestions made by the reviewer 2, and explain the few cases in which we were not able to follow some aspects of her/his suggestions.

This reviewer suggested major changes in the manuscript.

#### **Reviewer 2:**

1) It is crucial to add maps indicating the sample positions, the regional oceanographic settings (ocean currents) the isotherms and nutrient & chlorophyll distribution (at least in summer and winter).

***Re: We agree. This issue will be included as a new figure, i.e., core-sites locations, topography, main surface currents, and seasonal Chlorophyll concentrations for the study area.***

2) In order to explain the observed deviations from a single linear UK37'-SST calibration, the authors should consider other possible factors such as seasonal SST variations and growth at depth coupled with vertical temperature gradients. The authors could also check the thickness of the seasonal thermocline (based on wind stress Atlas data). Indeed, nutrient concentration may be related to the thermocline depth and thus explain local deviations of the Uk'37-SST.

***Re: We agree, we included figures and discussion about seasonal (winter/summer) water column temperatures (mixed layer vs. thermocline) variation. In order to explain the alkenone-based UK'37 deviations, we included seasonal (winter vs. summer) variations of thermocline/mixed layer depths from world ocean atlas (WOA01) in the context of the sediment's results.***

3) The discussion section (#4) is highly speculative when invoking subtle changes of upwelling conditions. The processes listed by the authors (summer productivity, deep chlorophyll

maximum, ENSO oscillation, river inputs, mesoscale eddies, upwelling filaments are only considered for their impact on the nutrient availability, with an assumed impact on UK37'. However, all of these features have also direct effects on the local hydrology and hence on the growth temperature of alkenone producers. The authors should thus assess these local thermal effects before they claim the detection of non-thermal effects on observed UK37' data. Overall, the authors should first study precisely the modern correlations between temperature, nutrients and productivity in order to demonstrate that they can separate the direct effect of nutrient on UK37' by using a simple statistical approach.

*Re: we agree, but we feel that our discussion is not totally based in speculations. They were writing in basis to the oceanographic scenarios described by several researches in the study area, which derived in potential explanations and/or assumptions for our results. Indeed, we included few statistical approaches, between the present-day's temperatures, nutrient and Chlorophyll concentrations, because clearly they improve our discussion to response when and where do thermal/non-thermal factors control the sedimentary UK'37-signal.*

5) On page 550, it is stated that the alkenone samples cover the Holocene period, which is a rather long period of non-negligible climate variability. The authors should thus provide information on the sedimentation rate for each individual core in order to demonstrate that observed deviations are not simply due to long-term warming at a particular site.

*Re: We agree, this is an important issue and we have been very careful in using core tops which have been previously published in the study area (e.g., Romero and Hebbeln, 2003; Prahl et al., 2006).*

*Several published records along the Peru-Chile margin, have described that the sedimentation rates of near-surface sediments range around between 0.04 and >0.20 cm yr<sup>-1</sup>, increasing successively southward off Chile (e.g., Hebbeln et al., 2001; Muñoz et al., 2004). This latitudinal pattern responses to different climate/oceanographic regimes, the resulting terrigenous/marine inputs, topography, winnowing, and also bioturbation effects (mixed layer thickness); factors that strongly determine if the near-surface sediments represent over the past hundred (e.g., sediments off Peru and northern Chile) or few thousand years because of*

winnowing and/or bioturbation effects (e.g., sediments off central Chile) (e.g., Hebbeln et al., 2001; Muñoz et al., 2004).

*Although surface sediments may cover the last several hundred years of deposition, they are all of Holocene age, and thus can be considered suitable for the objectives of this study. In fact, the use of alkenone-based unsaturation-index has been vigorously employed to estimate the physical properties of water masses in paleoceanography (e.g Müller et al., 1998). Furthermore, this method is based upon the presumption that the C<sub>37</sub>-alkenones compositions in coccolithophorids are determined by the temperature changes in the ambient water mass where coccolithophorids grew and thus, the difference in the unsaturation-index values from alkenones-producer species could serve as an effective monitor of the structure of the upper water column, like others paleoceanographic proxies in sediment used along the Peru-Chile margin (e.g., Mohtadi et al., 2004). However, several complex processes such as the physiological effects by nutrient/light-stress (e.g. Prahl et al., 2006), may overprint alkenone-based environmental record (e.g., Conte et al., 2006). By the way, we based in the previously published information plus statistical approaches proposed by the referees, we try to argue that alkenone-signal recorded in sediments from the Peru-Chile margin, should reflect the several changes produced by latitudinal, seasonal, offshore and water column depth factors, and how potentially these can be quantified.*

6) Introduction : add a paragraph about the oceanographic settings in the Peru-Chile system.

**Re: Done. This was included at the new manuscript version.**

7) Page 548 line 13 : give references for lab experiences and field studies

**Re: Done. This was included at the new manuscript version.**

8) Page 549, line 18 : replace 'longitude' by 'length'

**Re: Done.**

10) Page 550, line 17 : show a plot of the overall relationship Uk'37 vs maSST

***Re: Done. We included a plot for the Peru-Chile margin.***

11)Line18 : 'Moreover, the Uk'37/SST does not change seasonally' This might only be true for the equatorial region but not for samples from > 10S ?

***Re: We agree. On the new manuscript version, we included other figure that show the latitudinal distribution of residuals, i.e., UK'37-based temperatures minus measured temperatures (winter/summer temperatures from WOA01), along the Peru-Chile margin. Clearly, sediment sites from > 10°S of latitude (upwelling areas) exhibit important differences (e.g., summer = -8; winter = -4), in contrasting those from equatorial areas (e.g., summer = -1; winter = 2).***

12) Line 23: what time interval is integrated by the maSST and nutrient NOAA Atlas datasets? Do you use annual mean nutrients values? Do nutrient concentrations show a seasonal variability? In order to better constrain the growth period of coccolithophorids, you should consider a proxy for thermocline depth (wind speed Atlas data) in the three areas and at different latitudes.

***Re: The time integrated for maSST and nutrients include a climatology for the last ~50 years (Conkright et al., 2002). In the first version, we used annual mean nutrient dataset from WOA01. But, how nutrient concentrations exhibit important seasonal changes (winter vs. summer), we incorporated in some analyses this variable, to figure out the coccolithophorid's growth nutrient conditions. Moreover, we calculated the real thermocline temperatures and depths along the Peru-Chile margin (according to Kara et al., 2003). In fact, the results obtained were included in all statistic approaches, new figures, and also was possible to get thermocline's nutrient concentrations.***

11) Line 21, 22: Fig. 3 shows important differences in the upwelling index between 30°S-36°S and not 34-36°S.

**Re: Done.**

12) Line 23-25: to what correspond the black rectangles in Fig. 3: samples from costal upwelling and transition area (like described in the text) or >200km offshore samples (like indicated in the legend of Fig. 3)?

**Re: Black rectangles in Figure 3, correspond to samples from costal upwelling and transition area.**

#### **References:**

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