We answer to the comments made by Reviewer #2 about our manuscript cp-2010-43 entitled "Sea-surface salinity variations in the northern Caribbean Sea across the mid-Pleistocene transition" by Sepulcre *et al.* submitted to Climate of the Past. We would like to thank Reviewer #2 for his comments that helped to improve the quality of our manuscript. We acknowledged all the comments, and we took into account the proposed technical revisions. The two main points of the review are about i) the age model used for core MD03-2628 and ii) the discrepancies between the past sea-surface temperature records in the Caribbean Sea. In order to precisely answer to Reviewer #2, we provide 5 supplementary figures and one table (among which one figure and the table are shared with the answer to the first review of the manuscript). We also took into account the minor suggestions made by Reviewer #2 in the revised version of our manuscript and we provide here a point by point reply to his comments.

1. Sedimentological informations about core MD03-2628.

Reviewer #2 asks for further details about core MD03-2628 length, sedimentology and core scanner data.

In the Section 4.1 of the manuscript, we cite Sepulcre *et al.* (2009) for a detailed description of core MD03-2628 stratigraphy. Indeed, the full core description (lithology, structure, drilling disturbances and comments about sediment composition) is available in this previous article as supplementary material (Figures S1a and b in Sepulcre *et al.,* 2009). Briefly, core MD03-2628 is a continuous carbonate-enriched periplatform ooze without any hiatus. The only disturbance described is located at the core top, where drilling has produced a void at the first 5 cm of the core.

In order to help the reader to find these informations, we now specify in Sections 2. and 4.1. of the revised manuscript that the full description is available as supplementary material in Sepulcre *et al.* (2009).

2. Setting of core MD03-2628 age model.

Reviewer#2 asks for more informations about core MD03-2628 age model and associated errors. In particular, reviewer #2 questions the impact of low sedimentation rates coupled with the coarse sampling resolution, especially during glacial stages, on the calculation and interpretation of the past $\delta^{18}O$ of seawater.

The methodology used to establish core MD03-2628 age model has been fully developed and discussed in a previous published paper (Figure S2 of Sepulcre *et al,* 2009). Briefly, the age model of core MD03-2628 is based on ^{14}C measurements on planktonic foraminifera *Globigerinoides ruber* (*G. ruber*) for the upper part of the core, isotopic stratigraphy by stacking the $\delta^{18}O$ of *G. ruber* to a reference record (Lisiecki and Raymo, 2005) and paleomagnetic measurements that allowed to assess the time interval of the Bruhnes-Matuyama reversal.

We are aware that our correlation is based on few control points, especially during glacial stages and Terminations, due to the low sedimentation rates and coarse sampling resolution. The $\delta^{18}O$ of benthic foraminifera *Cibicidoides wuellerstorfi* (250 – 355 μm) was measured to reinforce the isotopic stratigraphy established with the $\delta^{18}O$ of *G. ruber* and to evaluate the synchronicity between both $\delta^{18}O$ records during glacial-interglacial changes (Figure S1). Both $\delta^{18}O$ records are in good agreement indicating that the correlation procedure would have been the same by using the benthic $\delta^{18}O$ record of core MD03-2628. Therefore, we have confidence in the use of the $\delta^{18}O$ of *G. ruber* record to perform our correlation and in the chronological framework established for core MD03-2628 at the studied temporal resolution.

Reviewer #2 asks to evaluate the age model errors associated to core MD03-2628 chronology. It is quite difficult to give an error associated to our methodology since most of the chronology is based on isotopic and paleomagnetic stratigraphies (except for the upper 1.2 m of core where ^{14}C data are available). In order to better constrain the errors associated to core MD03-2628 chronology, we decided to produce two new age models based on reference records for which a precise chronology is available, that are i) the composite $\delta^{18}O$ record of Asian stalagmites dated by Uranium-Thorium compiled by Cheng *et al.* (2009) for the last 350 ka (Figure S2a) and ii) the Antarctic CO_2 record with the Kawamura *et al.* (2007) chronology based on the O_2/N_2 ratio for the last 360 ka (Figure S2b). Unfortunately, reference records with such precise chronologies do not extend beyond ≈350 ka, so we can only test the first 350 ka of core MD03-2628 original chronology. However, since the timing of last 350 ka is better constrained than older time-intervals, comparison between different age models for this period should highlight major discrepancies between the chronologies. The MD03-2628 $\delta^{18}O$ record of *G. ruber* was correlated to the two reference records (Figure S2a and b). When comparing the original age model of core MD03-2628 to the new based on the composite stalagmites records (Cheng *et al.,* 2009), differences of –2.4 ka (std.dev.= 2.5, n=33) and of 2.3 ka (std.dev.=6.9, n=19) for interglacial and glacial stages, respectively, are determined. Calculations with the age model based of the Antarctic record with Kawamura *et al.* (2007) chronology yield average differences of -1.3 ka (std.dev.=3.6, n=33) during interglacials and of 0.01 ka (std.dev.=4.2, n=19) during glacials. The comparison between the three different chronologies does not exhibit clear differences at our temporal resolution (Figure S3). However, the calculation of these different age models allows us to chose as a conservative estimate a mean relative error for the age model of core MD03-2628 of about ± 2.5 ka.

This value can be used to assess the impact of the uncertainty in the age model on the correction of the global ice-volume effect (IVE) on the $\delta^{18}O$ of *G. ruber*. The original age model was shifted by ± 2.5 ka before correcting the $\delta^{18}O$ of seawater (that is the $\delta^{18}O$ of *G. ruber* corrected from the temperature effect) from the IVE given by the records of Bintanja and van de Wal (2008) and Waelbroeck *et al.* (2002). As expected, the impact of a change in the age model on the $\delta^{18}O$ IVE is stronger for glacial stages, when sedimentation rates are low, than during interglacial stages. We provide a new record of the $\Delta\delta^{18}O$ of seawater that takes into account a ± 2.5 ka error in the age model (Figure S4). Finally, we still observe a glacial-interglacial signal for the last 940 ka. The long-term change in the values of the $\Delta\delta^{18}O$ of seawater during the last five interglacial stages is still observed (Figure S4). As suggested by Reviewer #2, the limited impact of variations in the age model during interglacial stages may be related to the higher sedimentation rates during these time-periods.

In order to reinforce our interpretation, we add to the revised version of the manuscript details about the relative uncertainties in core MD03-2628 age model by using different reference records in the Section 4.1. We also provide a $\Delta\delta^{18}O$ of seawater record that takes into account the estimated uncertainties in Figures 7c and 8a by calculating the average $\Delta\delta^{18}O$ of seawater and associated errors (Section 4.3.).

3. Comparison between sea-surface temperature (SST) records of the Caribbean Sea

Reviewer #2 questions about the differences between the SST records of the Caribbean region, and the impact of these differences on the calculation of the $\delta^{18}O$ of seawater.

In this paper, we provide the first alkenone-SST estimation from the Caribbean Sea. Thus, we compare our results with other SST records reconstructed by the Mg/Ca paleothermometer (Schmidt *et al.,* 2006) and the foraminiferal transfer function (FTF) (Martinez *et al.,* 2007) (Figure 6 and Section 4.2. of the manuscript). There is an overall good agreement between Mg/Ca and alkenone SST reconstructions despite some differences, especially during MIS5. If we take into account the uncertainty associated to both SST reconstruction methods (0.7°C and 0.4°C for alkenone and Mg/Ca paleothermometers, respectively), most of the SST differences are within the uncertainties. Errors associated with the FTF from Martinez *et al.* (2007) range between ± 0.5 and 1.5 °C, with an average of ± 1 °C and a highest standard deviation of 2.2°C for MIS 14. Thus, alkenone and FTF reconstructions are similar within the uncertainties of both methods except for the time-interval older than 450 ka.

In details, SST records during MIS5e are different, with higher SST for the Mg/Ca record of Schmidt *et al.* (2006) than for the alkenone reconstruction. One of the possible explanations for the offset is the different sedimentation rates between the archives: the lower time resolution of core MD03-2628 may have smoothed the SST signal and its amplitude compared to the record of Schmidt *et al.* (2006).

Alkenone and FTF records are in agreement until MIS 13-14. According to Martinez *et al.* (2007), the average distance to the nearest analog tend to increase with time with maximum values reached during MIS13-14. Thus, SST reconstructions by FTF can not be considered as fully robust before 450 ka.

Finally, the alkenone-based SST record of core MD03-2628 is compared to different SST records that all come from the core ODP999A from the Caribbean Sea (Schmidt *et al.,* 2006; Martinez *et al.,* 2007). The reconstructed SST records from the same core exhibit differences, highlighting that there may be some discrepancies between different proxies even from the same marine archive.

We agree that the temperature difference could have an impact on the calculated $\delta^{18}O$ of seawater. However, the long-term $\delta^{18}O$ trend that we discuss already appears in the $\delta^{18}O$ of *G. ruber* without SST correction. On average, the temperature signal only accounts for around 0.2‰ of the total amplitude of change in the $\delta^{18}O$ signal during Terminations. This is of the same order of magnitude than the error in the $\delta^{8}O$ corrected from SST ($\delta^{18}O_{SST\text{-}corr.}$) after propagation (0.23‰) and lower than the global amplitude signal of 1.46 ‰ in the $\delta^{18}O_{SST\text{-}corr}$ during Terminations. Finally, as pointed out by Reviewer #2, we only discuss processes of which timescale is of higher magnitude than the coarse sampling resolution of core MD03-2628. Thus, our interpretations at glacial-interglacial timescale as well as over the Mid-Pleistocene Transition are still valid.

Nevertheless, to take into account this comment of reviewer #2, we develop the comparison between the different SST records in Section 4.2. and extend the discussion about the implications in the calculation of the $\delta^{18}O$ of seawater in the Section 4.3 of the revised manuscript.

4. Impact of the different ecologies between coccolithophorids and planktonic foraminifera.

Reviewer #2 asks some precisions about the possible changes in the growth seasonality and depth in the past.

We can gain some insight into the impact of these processes on hydrological ($\delta^{18}O$ of seawater) reconstructions by studying modern conditions, as already described in Section 2.4. of the manuscript. At the studied site, the thermocline is not well-defined, with nearly constant temperature values of around 27°C down to 50 m of water depth, followed by a progressive decrease to reach 15°C at 400 m (Figure S5). According to the literature, coccolithophorids (Kameo *et al.,* 2004) and *G. ruber* (Schmuker and Schiebel, 2002) both dwell in nearly the same depth range in the water column and thus, they inhabit under almost identical temperature conditions (Figure S5). In the past, changes in the seasonality or in the ecology of coccolithophorids and of *G. ruber* are difficult to estimate. Following Kameo *et al.* (2004), changes in the coccolithophorids population over the past 300 ka were controlled by the nutrient supply rather than the temperature influence, and the studied groups have always occupied the first 50 m of the water column. To our knowledge, there is no precise study about changes in *G. ruber* ecology in the past in the Caribbean Sea. However, as *G. ruber* is a symbiont-bearing species, the individuals could not inhabit water depths below 50m. Thus, we believe that changes in the growth depth would have not altered significantly the climatic signal in the past SST record.

The impact of seasonality signal is difficult to estimate at core MD03-2628 site. Indeed, the low sedimentation rates at core MD03-2628 site (2 and 4 cm/ka during glacial and interglacial stages, respectively) may have contributed to smooth the record. Moreover, we know from modern conditions that the seasonality signal in the SST record is weak. Thus, in the following, we consider that the impact of the seasonality signal can not have significantly biased the climatic record at core MD03-2628 site at the studied temporal resolution.

In order to improve the clarity of the discussion, we have developed the modern description of planktonic foraminifera and coccolithophorids habitats in Section 2.4. We also provided Figure S5 as a supplementary figure to the revised version of the manuscript. We describe the potential impact of the past changes in the different ecologies of foraminifera and coccolithophorids in the Section 4.3. of the revised manuscript.

5. Determination of time-intervals.

Reviewer #2 asks precisions about the choice of the three time-intervals we decided to compare.

Down-core variations in the $\delta^{18}O$ of *G. ruber* allow to divide the record in different time-intervals. Except for MIS 16, the $\delta^{18}O$ values for glacials are nearly constant for the overall record (Figure 4a of the manuscript). From 940 to 650 ka, Terminations are marked by $\delta^{18}O$ variations of about 1 ‰ whereas glacial-interglacial amplitudes across Terminations for the last 450 ka increased to approximately 2 ‰ (Figures 4a and 5 of the manuscript). This is mainly due to a shift in the average interglacial stages values that decreases over the last 450 ka compared to the older time-interval (Figures 4a and 5 in the manuscript). Between 650 and 450 ka (from MIS 16 to MIS 13), we observed a very high value for MIS 16 out of the range for the other glacial $\delta^{18}O$ values recorded and a $\delta^{18}O$ value for MIS 14 as high as a cold event during MIS 15 (Figures 4a and 5). Thus, the $\delta^{18}O$ of *G. ruber* can be used to define three time-intervals that are i) the period older than 650 ka, ii) the 450-650 ka time-interval, and iii) the last 450 ka. According to the literature, the Mid-Pleistocene Transition (MPT) ended between 1,000 and 650 ka, thus corresponding to the oldest part of core MD03-2628 $\delta^{18}O$ record (e.g., Head and Gibbard, 2005). The definition of the last five climatic cycles as a particular time-interval covering the last 450 ka is clearly expressed in the change in the amplitude of glacial-interglacial Terminations in core MD03-2628 record (Figure 5) as well as in other climatic record (e.g., the past changes in the atmospheric CO_2 record from EPICA, Figure 8c). Finally, the determination of the 650-450 ka time-interval as a transition period between two different climate modes is reinforced by recent studies (Tzedakis *et al.,* 2009; Yin and Berger, 2010).

Thus, we decided to maintain these temporal intervals in the revised version of the manuscript and we defined these different periods in more details in Section 1.

6. Inter Tropical Convergence Zone (ITCZ) migration and/or intensification.

Reviewer #2 suggests that an intensification of the ITCZ may be an alternative explanation for the shift in the $\Delta\delta^{18}O$ values observed for the last five interglacial stages.

We fully agree with this comment, because an intensification of the strength of the ITCZ may also have produced a decrease in the sea-surface salinities during the last five interglacial stages. We have chosen to discuss the ITCZ shift rather than intensification because the mechanisms involving the ITCZ migration have been evidenced at MPT timescale (see Discussion in the sections 5.2 and 5.3 of the manuscript and references cited) whereas processes involved in the intensification of the ITCZ have not been identified. Indeed, warmer SSTs in the Northern tropics could have resulted in more intense atmospheric convection and thus, more intense rainfall resulting in reduced interglacial SSS. However, there is no clear long-term trend observed in SST records from other locations in the tropical area over the MPT (de Garidel-Thoron, 2007; Liu et al., 2008). Thus, the impact of warmer SST on the ITCZ intensity at MPT timescale seems unlikely, and we still discuss processes involved in ITCZ migration.

Nevertheless, in order to precise the other potential processes that could explain our results, we add in the Section 5.1.2. on the revised version of the manuscript the intensification of the ITCZ as an alternative explanation for our results.

7. Comments about modern climatic and hydrological conditions.

Reviewer #2 has two questions about the modern setting exposed in the manuscript, about the relationships between evaporation and salinity on the one hand, and about the ITCZ seasonal migration on the other hand.

The lack of relationships between evaporation and sea-surface salinities (SSS) in the Caribbean Sea in modern conditions is illustrated by the comparison between the monthly variations of both parameters as shown in the Figure 2 of the manuscript. However, to our knowledge, there is no publication about this topic. We assume that the evaporation rate is not the main factor controlling the SSS at the studied site by comparing the monthly variations of both parameters (Figure 2). In particular, SSS values tend to be higher at lower evaporation rates from August to December, for example. From January to June, SSS tend to rise whereas the evaporation rates decrease. We deduced from this comparison of the datasets that the observed trend is the inverse from the expected relationships. Thus, we still have confidence in this observation that there is no clear relationships between SSS and the evaporation rates.

The second comment of Reviewer #2 relies on the seasonal migration of the ITCZ in modern conditions. We agree that Section 2 can be improved in clarity by better documenting the seasonal ITCZ migration at a global scale, and by separating this description from the relationships between ITCZ location and the studied site. Thus, the revised manuscript takes into account this comment by clarifying this point in Sections 2.1 and 2.2.

8. Methodology of $\delta^{18}O$ measurements

Reviewer #2 questions about the number of individuals of *G. ruber* analysed as a correct approach to assess the global $\delta^{18}O$ signal.

Measurements have been performed on a mass spectrometer especially dedicated to the analysis of small samples providing low gas amounts (Finnigan Delta Advantage mass spectrometer directly coupled to an automatic carbonate preparation device Kiel device III). Thus, for technical reasons, we can not work with more than 5 to 10 individuals of *G. ruber*. But our approach is validated by replicate measurements of same levels (Table S1) at different depths in the core, showing no significant shift as presented in Table S1.

In order to support our technical approach, we provide Table S1 as a supplementary material in the revised version of the manuscript.

9. Minor comments and suggestions.

The reviewer also proposed some corrections, and suggestions of data representation that we all have included in the revised manuscript.

Page 1230, Line 13, Section Abstract: "At longer timescale…" has been changed into "A long-term trend…"

Page 1231, Line 21, Section 1. Introduction: The sentence begining by "In this work, we sought…" has been removed.

Page 1237, Line 4, Section 3. Methods: "Core MD03-2828…" has been corrected into "Core MD03-2628…".

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