Reply to comments from reviewer #3

First and foremost, we would like to thank reviewer #3 for his positive assessment of our article. He raised several important points that made us modify the text of our article, and as a result, we feel that the final product is much improved. Below, we discuss the main points, then we answer the specific comments from reviewer #3.

Coral database

Reviewer #3 pointed out the incompleteness of our Sr/Ca database and the unclear criteria that lead us to the selection of the different Sr/Ca records used in our study. We originally used mainly *Porites* Sr/Ca records, and only 2 other genera of coral Sr/Ca records (*Siderastrea* and *Montastrea*). Given that the only mean Sr/Ca-SST calibration established by Corrège 2006 is for the coral genus *Porites,* we finally chose to restrain our database to the *Porites* Sr/Ca records.
One of the main criteria for our database is that the records should have a monthly resolution. However, following the recommendation of reviewer #3 we extended this database with one monthly resolved record (Stephans et al., 2004) and two annually resolved records (Felis et al., 2010; Wu et al., 2013).

SSS databases

Reviewer #3 pointed to us the weakness of the SODA SSS dataset that is a reanalysis product "that involves a lot of modelling, and that in many oceanic regions does not include real salinity observations » (see reviewer #2). We were also aware of this shortfall, and we agree that we did not give enough explanations to justify our choice of using SODA. Unfortunately, there are no in situ SSS datasets available at Clipperton atoll or at any other sites used in this study, except at Amedée Island but the data are not publically available. In the new version, we follow the recommendation of reviewer #3 and test the correlation between the ΔT and the IRD (Delcroix et al. 2011) SSS (« gridded SSS product based on historical instrumental observations ») at the 10 tropical Pacific sites. We see some slight differences between the SODA SSS-ΔT relationships and the IRD SSS-ΔT relationships at monthly and interannual resolution, but no overall trend can be identified from these results. The conclusions of our study remain unchanged. We change our text to :

Lines 187-194: However, the SODA SSS product is the only global ocean gridded SSS database currently available, making it the only possible choice for this study. To test the potential limitation of the seasonal and interannual SSS variability in the SODA SSS product at our sites, we investigated the correlation between ΔT and SSS using the 1°*1° gridded instrumental IRD SSS product (covering 120E-70W, 30N-30S; Delcroix et al., 2011) at 10 tropical Pacific sites of our database (Table S2 and S3). The IRD SSS product data set is made freely available by the French Sea Surface Salinity Observation Service (http://www.legos.obs-mip.fr/observations/sss/)

Lines 213-220: The reliability of the SODA SSS product was tested by calculating the coefficient of determination between ΔT and SSS at monthly and interannual resolution using both SODA SSS and IRD SSS products (Delcroix et al., 2011) at 10 tropical Pacific sites. The coefficients of determination between ΔT and SSS varies depending on the SSS product used, but no consistent relationship is observed (Tables S1 and S3). For example, the interannual E.Santo R^2 decreases when using the IRD SSS product (R^2=0.64 with SODA SSS and

R^2=0.44 with IRD SSS; p<0.01) whereas the interannual Amédée R^2 increases when using the IRD SSS product (R^2=0.25 with SODA SSS and R^2=0.45 with IRD SSS; p<0.01) (Tables S1 and S3).

Reviewer #3 proposes to use another SSS reanalysis products (Behringer et al.,1998). We decided to use the SODA SSS product because it is regurlarly updated with new SSS data, and therefore we are confident that this product is more suitable for our study. We also looked for local SSS data at http://www.nodc.noaa.gov/General/salinity.html but most of the available SSS dataset begin during the early 2000's, corresponding to the end of our Sr/Ca records.

Statistical methods

First methods (temperature residuals)

Reviewer #3 : « *The use of the average coral Sr/Ca-SST slope from Correge (2006) is odd, especially for the different coral species, for the reasons given on page 1788. If the authors feel this is necessary, then they should scale up from the local or study derived calibration with SST and then the use the average SST but for just Porites, different species have different calibration slopes.* »

Response : Given that at each site, a specific Sr/Ca-SST relationship could be largely influenced by other factors, we decided to choose the most « universal » equation, based on an average of 38 published equations. By doing this, we think that we can limit to a minimum the site specific influence of other factors, including SSS. In our study, we first applied a site-specific calibration for each of the records (not shown in the final article). By doing so, we obtained the best fit between the Sr/Ca record and the SST at each site, « hiding » the influence of others factors on the Sr and the Ca integration. However, we agree that the mean equation derived by Correge (2006) for *Porites* might not be applicable to other genera. The mean SST from Correge (2006) could also introduce a bias (see reviewer #2 comments). Thus, we concentrated the presented work on the *Porites* genus, and used only the slope of the Correge (2006) equation as suggested by both reviewers. By doing this, some different relationships between ΔT and SSS are visible compared to the previous method used (entire equation). We add these sentences :

Lines 170-173: However, the intercept of the C06 equation is representative of a mean SST of 25°C, which is not the mean SST at all coral sites of our database. Thus, we decided to calculate SST anomalies rather than absolute SST, using only the slope of C06 (SST_{anom} = -0,0607*Sr/Ca).

Reviewer #3 : « *The examination of residuals from removing the SST from coral Sr/Ca is not a necessary step. If the correlation between coral Sr/Ca and SSS is low and not significant, then why would you expect a relationship in the residuals? Please perform a correlation analysis between coral Sr/Ca and SSS before looking at the residuals and add a table with these correlations. Furthermore, examine the residuals; if they are white noise, then there is nothing there* »

Response : There is often a significant correlation between coral Sr/Ca and SSS due to the covariation of SST and SSS on a seasonal timescale in the tropical oceans (Gouriou and Delcroix, 2002 ; see Table S1 and S3). Thus, we believe it is necessary to remove the SST signal from the Sr/Ca in order to highlight the other potential recorded effects.

Second method (Multiple and Simple Linear Regressions)

Reviewer #3 : Figure 3 « *These graphs are confusing. You are plotting coral Sr/Ca (x-axis) against coral Sr/Ca derived from an equation based on those same data? What is independent and dependent variables? This is circular. It would be better to plot the residuals of the calibration to show what is not explained by your equations.* »

Response : We agree reviewer #3 that the method used to compare the reconstructed Sr/Ca and the original Sr/Ca can be confusing and is somehow circular. Furthermore, we thought about it a bit more, and we think that this approach has a small bias in that SST and SSS are not truly independant variables in the tropical ocean, and are usually correlated at the seasonnal timescale. This fact results in the slope for SSS being significantly different from zero in the MLR, and in a regression coefficient slightly stronger for MLR compared to SLR. Thus, we suppressed the graph and references to this method.

Comparison with the foraminifera data

We decided to follow the recommandations of reviewer #3 and removed the discussion about the SSS influence in the foraminiferal Mg/Ca. We expanded the discussion about the laboratory investigations on abiogenic aragonite and on different coral genera as follows:

Lines 236-242: Our results are also in agreement with the recently published work of Pretet et al. (2013) who investigated the effect of salinity on the skeletal chemistry of cultured corals *Acropora sp*., *Montipora verrucosa* and *Stylophora pistillata*. The three coral genera were bred in three different aquaria with artificial seawater at a salinity of 36, 38 and, 40 psu. Although Pretet et al. (2013) did not work with *Porites sp*, and had a smaller salinity range, they reached similar conclusion; Sr/Ca, Mg/Ca, Li/Ca and U/Ca ratios measured in the coral skeleton does not vary with salinity changes.

Additional comments from reviewer 3:

« This lack of SSS records for testing salinity's influence on coral geochemistry has left some to question the influence of SSS on coral Sr/Ca paleothermometer but to say it is "highly debated" (page 1785, line 23) is unfounded and that statement is not supported with references. »

We suppressed the expression « highly debated » and we added a few references where the potential salinity influence on coral Sr/Ca is discussed (but not formally studied as in our study) :

Lines 95-99: The pioneering work of Weber (1973) demonstrated the potential role of water depth, seawater composition and salinity on physiological processes that in turn control skeletal chemistry. Since this study, the possibility of a salinity influence on coral Sr/Ca has been discussed (Swart, 1981; Sinclair et al., 1998; Shen et al., 2005) without reaching a definitive consensus.

Page 1784 line 21 : « *Please provide references for this first sentence and the other sentences that follow.* »

Done

Page 1785 line 24 : « *Please give citations for the studies that are debating a salinity influence in coral Sr/Ca*. »

Replaced by :

Lines 84-85: The role of salinity in the incorporation of trace elements in the skeleton of calcareous organisms is still under investigation.

Figure 1 : « *Use the same SSS data set that you are making your analysis with, not the a WOA which is averages. Better yet, have two panels, one with the Delcroix SSS data and the other as SODA.* »

We have deeply modified figure 1 to include both SODA and the Delcroix dataset.

Figure 2 : « *Color code the data for the different regions, Red Sea, Indian Ocean, etc. Remove the Mg/Ca since that is not your work*. »

Done

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Table S1. Summary of the coefficients of determination (R^2) between residual temperature and salinity (SODA SSS) at the different locations used in this study, at monthly (M) and interannual (I) resolution. The coefficient of correlation r between the SST and the SSS are also given for each sites at both resolutions. n is the number of values for each records. Correlations are significant at the 99% confidence level. The bolds values are discussed in the text.

Location	**R^2 (M)**	**R^2 (I)**	**r (SST;SSS) (M)**	**r (SST;SSS) (I)**	**Period and n (M and I)**
1-E.Santo,Vanuatu	**0.2**	**0.64**	**-0.47**	**-0.8**	(1981-1992) 128 and 104
2-Kavieng, Papua New Guinea	0	**0.2**	0.13	**0.44**	(1981-1997) 186 and 162
3-Rabaul, Papua New Guinea	0	0	0	0.15	(1981-1997) 189 and 165
4-Amédée, New Caledonia (Delong et al., 2012)	0	**0.45**	-0.26	**-0.36**	(1981-1999) 216 and 192
4-Amédée, New Caledonia (Stephans et al., 2004)	0	**0.36**	-0.28	**-0.64**	(1981-1992) 131 and 108
5-Ha'afera island, Tonga		0		0	
6-Rarotonga	0	0	0	-0.23 p>0.01	(1981-1996) 121 and 96
7-Christmas Island, Kiribati	0	0	-0.22	-0.27	(1981-1998) 199 and 175
8-Fanning, Kiribati	0	0	-0.1	-0.16	(1981-2005) 285 and 261
9-Palmyra, Central Pacific	**0.24**	**0.25**	**-0.49**	**-0.5**	(1981-1998) 198 and 174
10-Clipperton, East Pacific	**0.16**	0	**0.4**	0	(1981-2005) 275 and 251
11-Xisha, China Sea	0	0	-0.12	-0.25	(1981-1994) 151 and 127
12-Ogasawara, Japan		0.2 p>0.01		-0.13 p>0.01	(1982-1992) 13
13-Madagascar	0	0	-0.14 p>0.01	-0.25 p>0.01	(1981-1994) 79 and 66
14-Mayotte	0	0	-0.27	-0.3	(1981-1994) 75 and 62
15-Aqaba, Red Sea	0		-0.31 p>0.01		(1991-1996) 32

Table S2. Summary of the SST (OISST monthly product, version 2, Reynolds et al., 2002) and SSS (SODA SSS product v2.2.4, Carton and Giese 2008 and IRD SSS product, Delcroix et al., 2011) grid point for each location.

Location	SST grid point	SODA SSS grid point	IRD SSS grid point
1-E.Santo,Vanuatu	15°5'S-167°5'E	15°75'S-167°25'E	15°S-167°E
2_Kavieng, Papua New Guinea	2°5'S-150°5'E	2°27'S-150°25'E	2°S-150°E
3-Rabaul, Papua New Guinea	4°5'S-151°5'E	4°25'S-151°75'E	4°S-152°E
4-Amédée, New Caledonia	22°5'S-166°5'E	22°25'S-166°25'E	22°S-166°E
5-Ha'afera, Tonga	19°5'S-174°5'W	20°25'S-174°75'W	20°S-174°W
6-Rarotonga	16°5'N-112°5'E	16°75'N-122°25'E	21°S-159°W
7-Christmas Island, Kiribati	1°5'N-157°5W	1°75'-157°25'W	1°N-157°W
8-Fanning, Kiribati	3°5'N-159°5'W	3°75'N-159°25'W	3°N-159°W
9-Palmyra, Central Pacific	5°5'N-162°5'W	5°75'N-162°75'W	5°N-162°W
10-Clipperton, East Pacific	10°5'N-109°5'W	9°75'N-109°25'W	10°N-109°W
11-Xisha,China Sea	16°5'N-112°5'E	16°75'N-112°25'E	-
12-Ogasawara, Japan	27°5'N-141°5'E	27°75'N-141°75'E	-
13-Madagascar	23°5'S-43°5'E	23°25'S-42°75'E	-
14-Mayotte	12°5'S-44°5'E	12°25'S-45°25'E	-
15-Aqaba, Red Sea	29°5'N-34°5'E	28°25'N-34°75E	-

Table S3. Summary of the coefficients of determination (R^2) between residual temperature and salinity (IRD SSS; Delcroix et al., 2011) at the 10 tropical Pacific sites of the database, at monthly (M) and interannual (I) resolution. The coefficient of correlation r between the SST and the SSS are also given for each sites at both resolutions. n is the number of values for each records. Correlations are significant at the 99% confidence level. The bolds values are the most significant values.

Location	**R^2 (M)**	**R^2 (I)**	**r (SST;SSS) (M)**	**r (SST;SSS) (I)**	**Period**
1-E.Santo,Vanuatu	0	**0.44**	0.2	**-0.68**	1981-1992
2-Kavieng, Papua New Guinea	**0.2**	**0.64**	**0.46**	**0.86**	1981-1997
3-Rabaul, Papua New Guinea	0	0.1	0	**0.37**	1981-1997
4-Amédée, New Caledonia (Delong et al., 2012)	**0.1**	**0.25**	**0.36**	**-0.5**	1981-1999
4-Amédée, New Caledonia (Stephans et al., 2004)	0	**0.1**	0.26	**0.35**	1981-1992
5-Ha'afera island, Tonga		0		0	1982-2003
6-Rarotonga	0	0	0	0.27	1981-1996
7-Christmas Island, Kiribati	0	0	-0.2	-0.22	1981-1998
8-Fanning, Kiribati	**0.25**	**0.31**	**-0.53**	**-0.6**	1981-2005
9-Palmyra, Central Pacific	**0.1**	**0.21**	**-0.38**	**-0.41**	1981-1998
10-Clipperton, East Pacific	0	**0.1**	0	**-0.36**	1981-2005

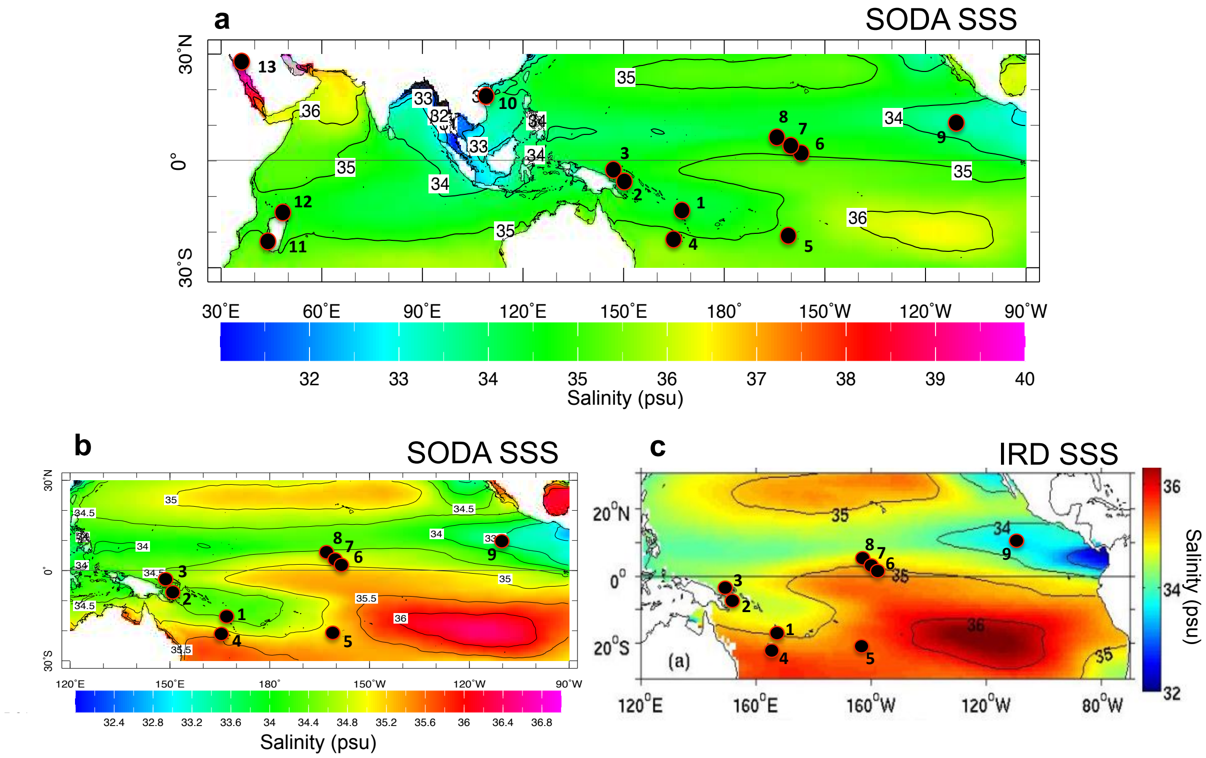

Fig. 1 Study sites (black and red circles) plotted over averaged salinity maps.
a : SODA SSS product v2.2.4, Carton and Giese (2008) averaged over 1982-2008 ; **b** : same as **a** but zoomed over the tropical Pacific Ocean to highlight the salinity structure in that zone and to compare it with instrumental IRD SSS product; **c** : Instrumental IRD SSS product (figure from Delcroix et al., 2011) over the 1950-2008 period.

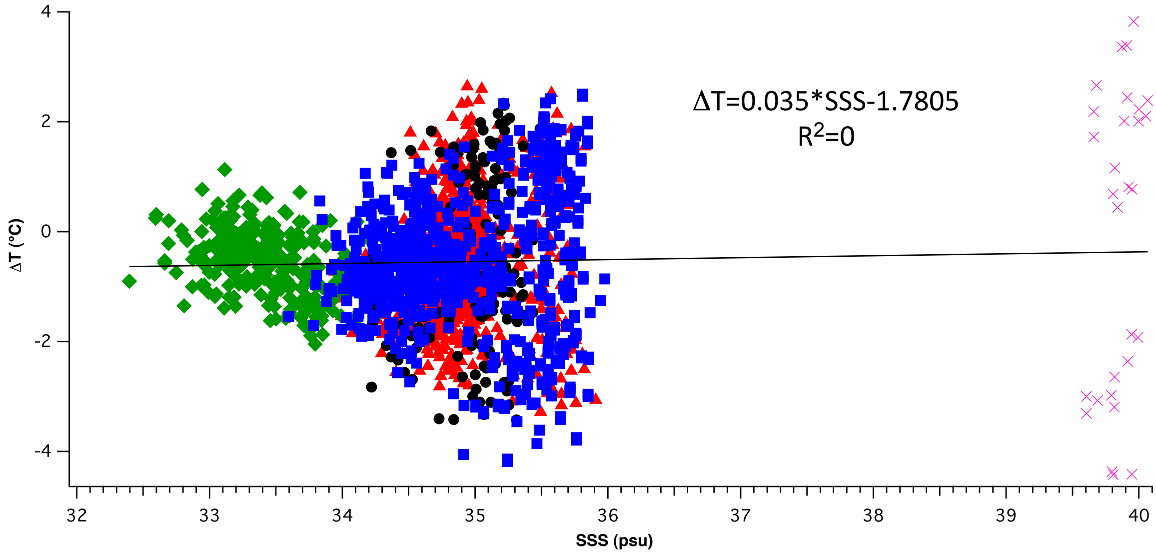

Fig. 2 ΔT (=$T_{Sr/Ca}$ - T_I) plotted against salinity (SODA SSS product v2.2.4, Carton and Giese 2008) at monthly resolution for all coral data. Green diamonds: eastern tropical Pacific; Blue squares: western tropical Pacific; Red triangles: central tropical Pacific; Black circles: Indian Ocean; Pink crosses: Red Sea.