Reply to comments from reviewer #2

First and foremost, we would like to thank reviewer #2 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 #2.

Coral database

Reviewers #2 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 #2, 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

Reviewers #2 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 ». We were also aware of this shortfall, and we agree that we did not give enough explanations to justify our choice of using SODA. In the new version, we follow the recommendation of reviewer #2 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 correlation and the IRD SSS-ΔT correlations 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).

Statistical methods

<u>First methods (temperature residuals)</u>

Reviewer #2 : Page 1788, line 10-20 and Page 1790, line 1-4: *« It might better anyway to calculate SST anomalies (using just the slope value of the Correge 2006 calibration) and not absolute SST, as the Correge 2006 calibration is representative for mean absolute SST of about 25 degC, which is probably not the mean SST at all coral sites investigated by Moreau et al. Therefore, this approach could probably lead to biases in the DeltaT calculation which, if true, should be acknowledged. »*

Response : We agree that the mean SST from Correge (2006) could also introduce a bias. Thus, we used only the slope of the Correge (2006) equation as suggested by reviewer #2. By doing this, some different relationships between ΔT and SSS are visible compared to the previous method used (entire equation) (see Table S1). 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).

Comparison with the foraminifera data

We decided to follow the recommandations reviewer #2 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 2:

Page 1785, line 9: *« 'limiting diagenetic effects', relative to what? Give more explanations, or delete. »*

Deleted

Page 1785, line 15-17: « *Provide more information or delete. As currently written, this sentence is not understandable for the general reader (attenuation leading to overestimation?). It should be mentioned that Gagan et al. have demonstrated this for coral d18O, and have extrapolated their findings to Sr/Ca. Importantly, this is not a problem confined to the Sr/Ca temperature proxy*. »

We modified the sentence to make it clearer :

Lines 79-81: Recently, a study showed that skeletogenesis within the living tissue layer could lead to an over-estimation of reconstructed SST (Gagan et al., 2012).

Page 1785, line 19: « *de Villier 1994 and Sun 2005 are missing in the reference list. »*

Done

Page 1785, line 20-21: *« There are probably equally or more important questions, such as the potential influence of growth rates (calcification rates) on the coral Sr/Ca temperature proxy and the correction for changes in the Sr/Ca of seawater on glacial –interglacial time scales*. »

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.

Page 1786, line 11-17: « *The between-site salinity range of 7 psu should not be directly compared to the salinity range of 34-35.3 psu observed in the Western Pacific Ocean at seasonal to interannual time scales. This paragraph needs to be re-arranged. »*

We corrected the sentences and rephrase it as follows:

Lines 107-112: Until recently, testing potential salinity bias on coral Sr/Ca thermometry was difficult because most coral Sr/Ca records originated from the Western tropical Pacific Ocean, a region characterised by a weak spatial mean salinity gradient (34.4-35.6 psu) (see figure 1 and Delcroix et al., 1998; Delcroix et al., 2011). Several *Porites* Sr/Ca records are now available in other regions encompassing a much larger salinity range (~7 psu) such as the Western subtropical Pacific Ocean, the Indian Ocean, the China Sea, and the Red Sea.

Page 1786, line 18: « *should be 'first…coral Sr/Ca record…' from Clipperton? »*

We have recently written a paper in collaboration with Wu, Linsley and Shrag concerning the Clipperton atoll and this paper is now in correction. In this paper, we test the inter-colonies replication and we interpret the Sr/Ca signal in term of climate variability ; a more complete record will appear elsewhere. Thus, we prefer to use « a newly » instead of « first ».

Page 1787, line 16: « *Peak matching using Reynolds (2002) SST? »*

We added this sentence :

The chronology is based on maxima and minima peak matching between Sr/Ca and the OISST monthly product (version 2, Reynolds et al., 2002).

Lines 134-136 : Page 1788, line 10-20: *« Are the authors sure that the transformed Correge 2006 calibration, converted to SST, is correct: SST = …. (line 11)?* »

Corrected

Page 1790, line 1-4: « *Please investigate and/or acknowledge that interlaboratory offsets in average coral Sr/Ca, vital effects resulting in different average Sr/Ca values for corals from the same reef site, and the use of the Correge 2006 regression to* *calculate absolute SST from corals that do not grow at mean SST of about 25 degC, could all contribute to the reported large range in calculated DeltaT. »*

We added these sentences :

Lines 208-212: The ΔT values presents a dispersion between +4°C and -4°C (Fig. 2); reasons for this dispersion are not well-constrained, but it could be due, for the most part, to interlaboratory offsets, as recently highlighted by Hathorne et al. (2013). Thus, we strongly support the conclusion drawn by Hathorne et al. (2013) stating that Sr/Ca coral data should always be corrected from an international standard.

References

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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