## Reply to comments from C. Saenger

First and foremost, we would like to thank C. Saenger 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 C. Saenger.

### Coral database

C. Saenger 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 Saenger, 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).

Concerning the others records proposed by reviewer Saenger, some of them are not publically available (deVilliers et al., 1994; Fallon et al., 2003).
The Calvo et al. record is a multi-annually resolved record with only 2 points (1988 and 1983) for the contemporaneous period of the instrumental data. These records are thus not suitable for our test.
W.-Chr. Dullo is a co-author of Zinke et al., 2008, therefore this record is already in our database (Mayotte).
The Hendy et al. (2002) record stops in 1983, at the beginning of the instrumental period.
The Stephans et al. (2004) record was omitted so we included it, and we thank the reviewer for pointing out this omission

All the other proposed records are from different genera of massive corals (Kuhnert et al., 2002; Bagnato et al., 2004; Saenger et al., 2007; Hetzinger et al., 2012).

### SSS databases

C. Saenger 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. In the new version, we follow the recommendation of C. Saenger 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 (see Table S2). 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 (see Table S3). 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

### First methods (temperature residuals)

*C. Saenger : « Their first method applies an average Sr/Ca-SST relationship for Porites sp. corals to derive a coral-based SST and compares its residual with a SODA salinity reanalysis. Given the considerable variability among Porites sp. Sr/Ca-SST calibrations highlighted by Dr. Correge's 2006 review, it does not seem reasonable to use this as a constant among all corals, especially those of other genera. »*

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. 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).

Page 1788, Line 23. « *This type of filtering reduces the degrees of freedom between timeseries and inflates r-squared values. The reduced degrees of freedom must be accounted for when calculating a p value to determine if the higher r-squared is significant. Please state if this has been done, and be sure to account for this effect if* *not done so already. »*

Response : The degrees of freedom are always accounted for when calculating the different p-value.

Second method (Multiple and Simple Linear Regressions)

Reviewer Saenger : « *The second approach simultaneously regresses coral Sr/Ca against both SST and SSS, then (in a rather circular approach) uses this relationship to reconstruct "theoretical" coral Sr/Ca, which is finally regressed against measured coral Sr/Ca. I prefer this multi-regressive approach, but find it unnecessarily convoluted. Would it not be more simple and straight-forward to perform the multiple linear regression, then determine if the slope of the salinity coefficient is significantly different from zero? »*

Response : We agree with C. Saenger 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 C. Saenger 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.

**New record from Clipperton atoll**

*« Better yet, presuming there are also CL1 and CL2 cores, perhaps a little more data would allow for a stand alone paper on intra- and inter-coral Sr/Ca variability in Clipperton Atoll Porites that could be compared with Henry Wu's work at the site. »*

Response : 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. Thus, a more complete record will appear elsewhere.

Following C. Saenger's request, we included information on water depth and on coordinates of the atoll in the Table 1, and in the main text.

**Additional comments from C. Saenger:**

Page 1784, Lines 19-21. « *Please provide some references for the extensive use of corals during the last 30 years*. »

Done

Page 1785, Lines 20-21. « *Please provide some references that suggest the influence of salinity on coral Sr/Ca is a major question among paleoceanographers. »*

We removed this sentence.

Page 1785, Lines 27. « *Replace with "seawater oxygen isotopic composition" to be specific about the isotope system you're discussing*. »

Done

Page 1786, Line 9. *« Give salinity units.* »

Done

Page 1786, Line 10. « *Provide the genus/species used by Pretet given that this manuscript too investigates corals other than Porites*. »

Done

Page 1786, Line 25. *« Provide more details on the sampling of CL3 including date, water depth and lat/lon.* »

We changed the text as follows:

Lines 118-121:

**2.1 Clipperton record (10°18N, 109°13W)**

In February 2005, a sampling expedition led by the Institut de Recherche pour le Développement France (IRD) collected a 1.94 m length *Porites* core (labelled CL3) at 10 m water depth with a hydraulic drill.

Page 1787, Line 15. « *Describe if both maxima and minima were peak matched or just one of the two. »*

We added this sentence:

Lines 134-136: The chronology is based on maxima and minima peak matching between Sr/Ca and the OISST monthly product (version 2, Reynolds et al., 2002).

Page 1789, Line 2. « "*MLR regression" implies the redundant "multiple linear regression regression" »*

Suppressed

Page 1789, Line 10. « *Change records to record.* »

Done

Page 1791, Line 3. « *Presumably, the underlying mechanism that would cause coral Sr/Ca to vary with salinity is changes in seawater Sr/Ca. I would also include a discussion of seawater Sr/Ca variability both spatially and temporally. Are the sites that exhibit a significant correlation between Sr/Ca and salinity close to riverine water sources with Sr/Ca ratios that differ from typical marine values? »*

We added additionnal information:

Lines 196-205: We observe a weak but significant relationship between ΔT and SSS at monthly resolution for Espiritu Santo island, Palmyra and Clipperton records ($R^2 = 0.20$, $R^2 = 0.24$ and $R^2 = 0.16$ respectively; $p<0.01$; Table S1). The reason for these significant relationships is still unclear; there are no rivers surrounding these core locations ruling out any freshwater input that could have modified the Sr/Ca seawater concentration (Kilbourne et al., 2004; Cobb et al., 2003; Linsley et al., 2000). One possible explanation could be a seasonal coupling between salinity and temperature variations. E.Santo island, Palmyra island and Clipperton atoll instrumental SSS and SST indeed present a significant correlation (r=-0.47; r=-0.49; r=-0.40 respectively; $p<0.01$; Table S1).

Figure 1: « *Please give the years for which the average salinity is calculated. Please also include a complementary table that gives the names, salinities, lat/lon and reference for the locations in Figure 1.* »

We added the information in the caption of figure 1, and we added Table 1 (see below).

**Table 1**. Summary of the different coral sites location, references and, periods of coral record used over this study.

| Site numbers | Location | References | Period |
|---|---|---|---|
| 1 | E.Santo,Vanuatu (15°7'S-167°2'E) | Kilbourne et al., 2004 | 1981-1992 |
| 2 | Kavieng, Papua New Guinea (2°5'S-150°5'E) | Alibert et al., 2008 | 1981-1997 |
| 3 | Rabaul, Papua New Guinea (4°S-152°E) | Quinn et al., 2006 | 1981-1997 |
| 4 | Amédée, New Caledonia (22°28'S-166°28'E) | DeLong et al., 2012 | 1981-1999 |
| 4 | Amédée, New Caledonia (22°28'S-166°28'E) | Stephans et al., 2004 | 1981-1992 |
| 5 | Ha'afera island, Tong (19°9'N-174°71'W) | Wu et al., 2013 | 1982-2003 |
| 6 | Rarotonga (21°14'S-159°49'W) | Linsley et al., 2000 | 1981-1996 |
| 7 | Christmas Island, Kiribati (1°52'N-157°24'W) | Nurhati et al., 2010 | 1981-1998 |
| 8 | Fanning, Kiribati (3°51'N-159°21'W) | Nurhati et al., 2010 | 1981-2005 |
| 9 | Palmyra, Central Pacific (5°53'N-162°5'W) | Nurhati et al., 2010 | 1981-1998 |
| 10 | Clipperton, East Pacific (10°18'N-109°13'W) | This paper | 1982-2005 |
| 11 | Xisha,China Sea (16°51'N-112°20'E) | Sun et al., 2004 | 1981-1994 |
| 12 | Ogasawara, Japan (27°6'N-142°11'E) | Felis et al., 2010 | 1982-1992 |
| 13 | Madagascar (23°8'S-43°34'E) | Zinke et al., 2004 | 1981-1994 |
| 14 | Mayotte (12°39'S-45°06'E) | Zinke et al., 2009 | 1981-1994 |
| 15 | Aqaba, Red Sea (29°27'N-34°58'E) | Felis et al., 2004 | 1991-1996 |

Figure 2: « *This figure would be more useful if it distinguished between site and coral genera. For example, each site could use a different symbol and different colors could be used for each genera. Consider removing the inset. I think it has little significance for your analysis*. »

Done except for the different genera because we now only use *Porites.*

Figure 3: « *Please provide a rationale for splitting the data at the specified SSS values. »*

We removed this splitting.

Supplementary material. « *In the table of regression statistics, please provide the slope +/- standard error for both the SST and SSS slope of MLRs*. »

Removed

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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 |

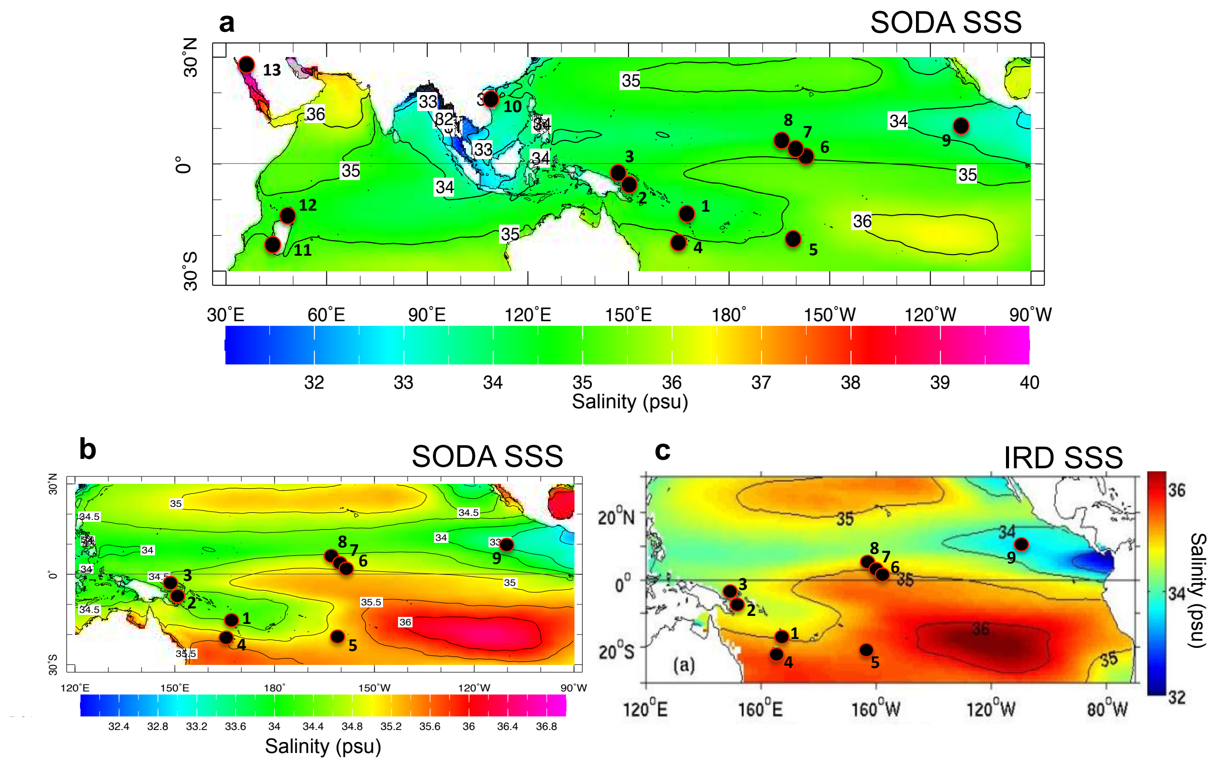


**Fig. 1** Study sites (black and red circles) plotted over averaged salinity maps.
**a** : SODA SSS product v2.2.4, Carton and Giese (2008) averaged over 1982-2008 ; **b** : same as **a** but zoomed over the tropical Pacific Ocean to highlight the salinity structure in that zone and to compare it with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

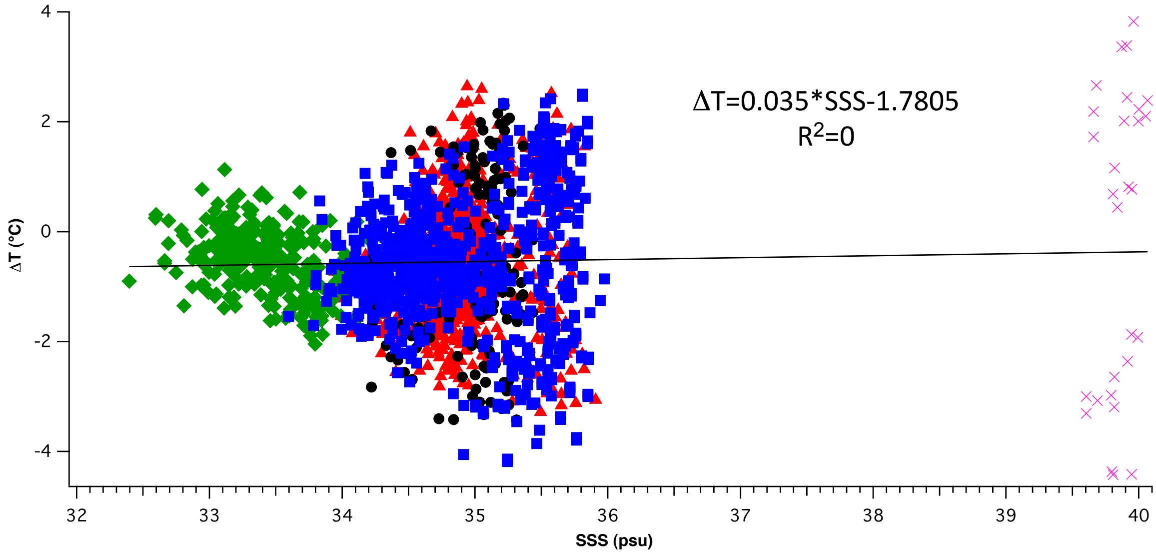


**Fig. 2** ΔT (=$T_{Sr/Ca}$ - $T_I$) plotted against salinity (SODA SSS product v2.2.4, Carton and Giese 2008) at monthly resolution for all coral data. Green diamonds: eastern tropical Pacific; Blue squares: western tropical Pacific; Red triangles: central tropical Pacific; Black circles: Indian Ocean;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