TaraTSG : final QC data for the 1st Year

H Le Goff 02/11/11

I- General

On the page **:** http://www.lodyc.jussieu.fr/~TaraTSG/
You will find the following Tara TSG data :

- ***taratsg_5.dat*** : real time data , updated from the data sent daily from Tara at sea since start in Lorient. Those data are non corrected/non calibrated data : 5 mn median averaged data from Lorient to Capetown, 10s sampled raw data from Capetown to San Diego . The graphs available on line show these real time data. They are not further discussed in this report.
- ***taratsgQC.txt*** : calibrated and corrected data for the 1st year from Lorient to Capetown only .

The following report details the QC final processing to obtain those data.

II- Format

JJ	decJJ	date	UTC	latitude (dec. Degree)	longitude (dec. Degree)	SSS (PSU)	SST (°C)
21797	57440	05/09/2009	15:57:20	47.30068	-3.87995	35.37406	19.48431
21797	57790	05/09/2009	16:03:10	47.29060	-3.89377	35.37647	19.45931
21797	57900	05/09/2009	16:05:00	47.28743	-3.89812	35.37907	19.46621
21797	58250	05/09/2009	16:10:50	47.27742	-3.91238	35.37997	19.44771

file starts on: 05/09/2009 13:59:00 in Lorient
file ends on : 16/07/2010 10:09:08 in Capetown
Due to the median averaging process (detailed in appendix 1) the sampling period is not strictly constant equal to 5mn.
Missing data are filled by *NaNs* if raw data were discarded by the post processing .
There are time gaps in the serie if the TSG was stopped (in harbour or at sea).

Comments on GPS positions

During year 1 , the TSG encountered major problems with its GPS interface (the odd Seabird grey box…) ; most of the gaps in the time series are due this problem . We tried to recover most of the missing data in post process by time correlations between TSG raw files and other GPS sources on board (FRRF on its own GPS, Seaclear on the board NMEA stream) . During some legs, GPS positions have therefore been interpolated.
This means that position data in those TSG files may be randomly biased from 5 to 10mn of degree (specially from Male to Capetown)

III-Calibration and Quality Control (QC) processing

The process is detailed in the appendix 1 .
In abstract and starting from the raw 10s instrumental data :

- GPS gaps are filled when possible, otherwise *NaNs*
- SSS and SST are averaged through a running median on a 5mn window
- Remaining outliers are removed by hand (visual check on the time series) and replaced by *NaNs*.
- Calibration coefficients (from pre and post cruise factory calibrations) are applied, assuming a linear time drift.
- Using calibrated/QC CTD profiles , S and T data in a depth range from 1 to 4 m are extracted and (spatially) averaged.
- For each valid CTD profile, they are compared to simultaneous TSG data (SST and SSS averaged on a ± 10 mn window around CTD time)
- (CTD- TSG) errors on SST and SSS are plotted against time, allowing detection of error trends
- If (*and only if*) these errors trends look consistent and caused by TSG , a correction is applied to TSG data (independently on SST and /or SSS) , generally computed from the error averaged leg by leg .

IV- Results

Corrections from factory calibrations :

After one year, arriving in Capetown , the maximum drifts were :

- 0.00009 °C on SST
+ 0.022 PSU on SSS

Temperature drift is not significant , being less than SBE38 initial accuracy (0.002°C)

Salinity drift is significant , being 4 times the SBE45 initial accuracy (0.005 PSU) .

Corrections from CTD inter comparisons :

89 CTD profiles have been considered as valid for TSG inter comparisons , among the 153 profiles validated by Vincent Tallandier *[ref 1]*.

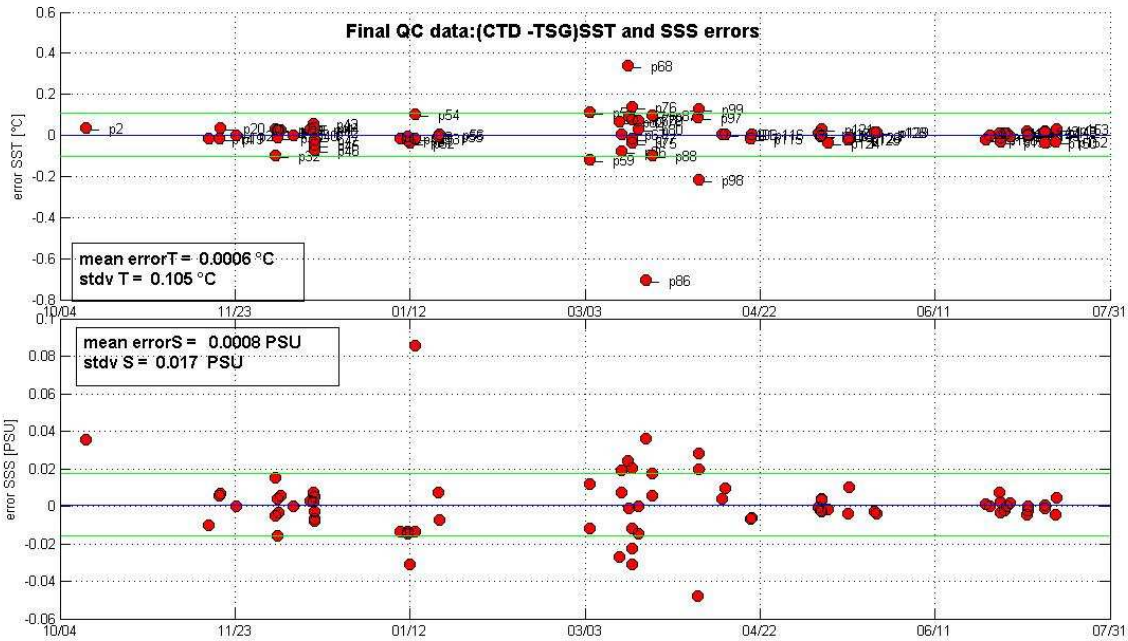
The maximum “leg “corrections (computed from the (CTD-TSG) errors averaged on the leg) are :

- + 0.55 PSU on SSS (Cyprus gyre leg)
- - 0.12°C on SST (Mumbay- Male leg)

All corrections , with corresponding valid CTD profiles are listed in appendix 2.

Final QC results :

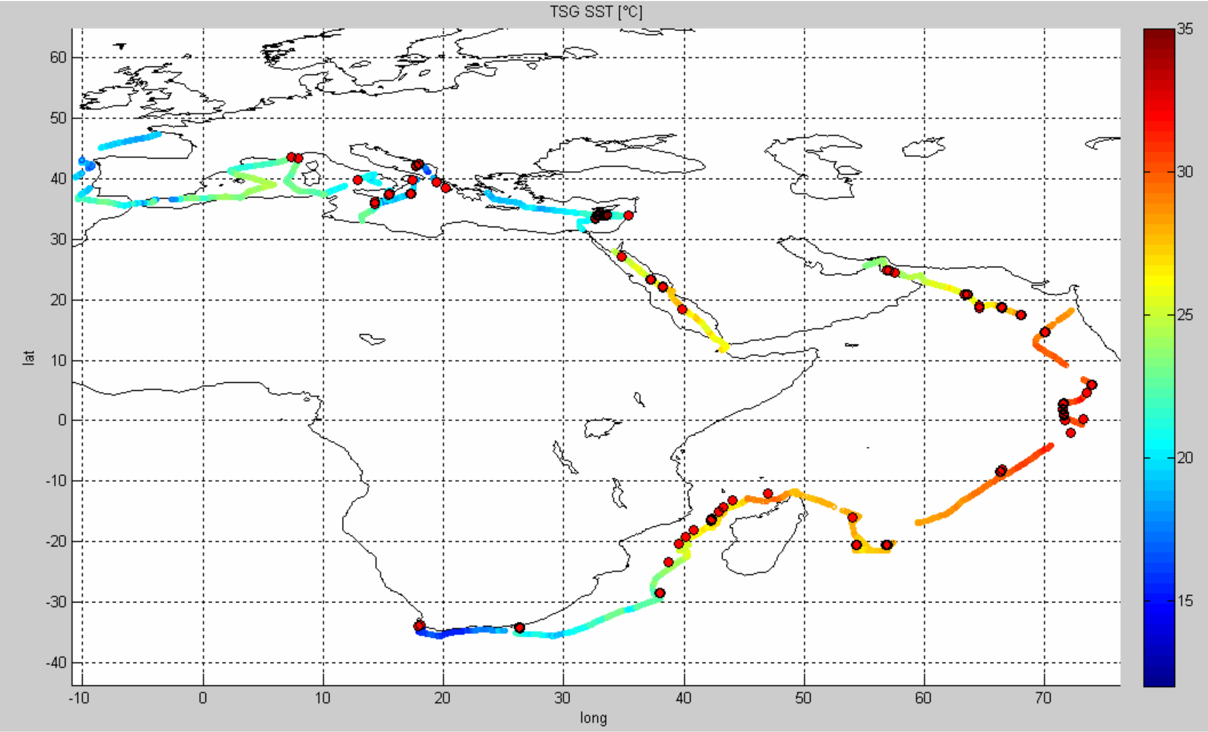
All corrections being applied, the final TSG/QC data show the following statistics when compared to CTD/QC data through the whole domain :

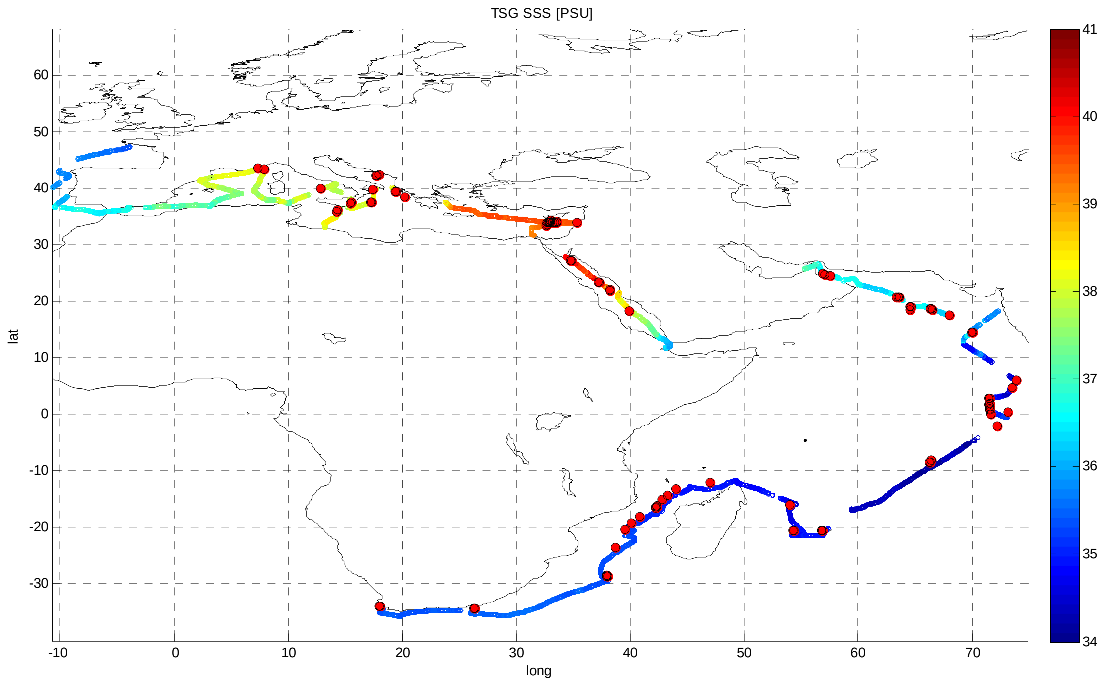


[ref 1] : Post-processing physical data acquired during the expedition TARA OCEANS (Year 1), *Vincent Taillandier, onboard TARA (leg Easter Island – Guayaquil), April 2011*

V- Data plots

Here are SST and SSS data plotted with concomitant CTD stations used for the QC process





Appendix n°1 : Filtering , calibration and correction process on TSG data

----

I- Filling GPS gaps on 10s raw data

During year 1 , the TSG encountered major problems with its GPS interface (the odd Seabird grey box…) ; most of the gaps in the time series are due this problem . We tried to recover most of the missing data in post process by time correlations between TSG raw files and other GPS sources on board (FRRF on its own GPS, Seaclear on the board NMEA stream) . During some legs, GPS positions have therefore been interpolated.
This means that position data in those TSG files may be randomly biased from 5 to 10mn of degree (specially from Male to Capetown)

II- Averaging 10s raw data

A running median (window 5mn) is applied to SSS . Then the first occurrence of this median SSS value is searched in the 5 mn window ; the corresponding SST value and time stamp are associated .
This is the reason why the sampling period in the final QC data is not exactly constant and equal to 5mn .

III- Filtering outliers

Despite the median averaging, outliers still remained in the time series which were removed by various filters :

-high and low limits filter on SST /SSS:
$13 < SST < 35$ °C and $32 < SSS < 41$ PSU
-zero phase/high pass filter on SST/SSS (with window $\Delta t = 10$ mn for the running median)
$\Delta T/\Delta t < 0.02$°C/mn $\Delta S/\Delta t < 0.02$ PSU/mn

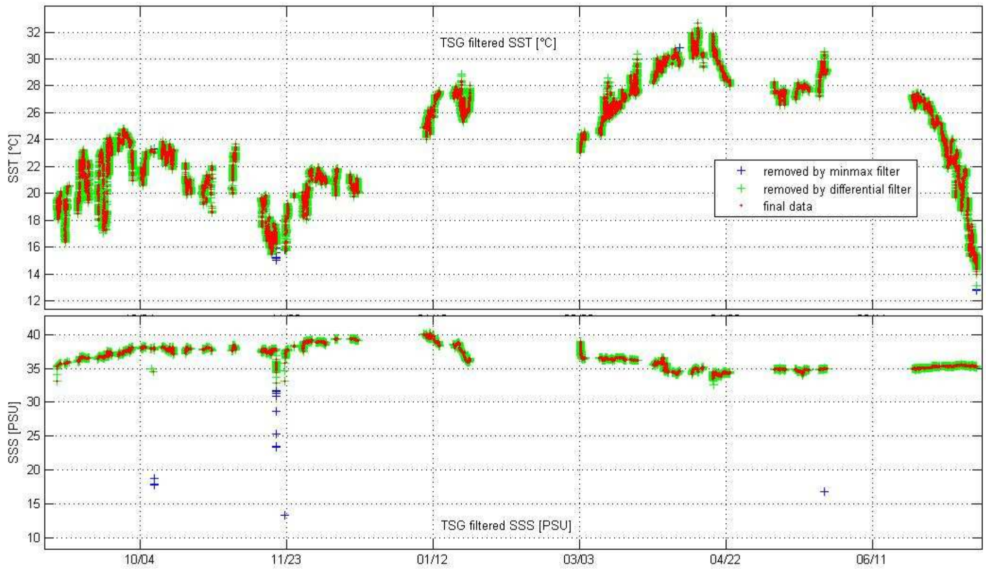


Figure 1 : filtering outliers on SSS and SST time series (ensemble)

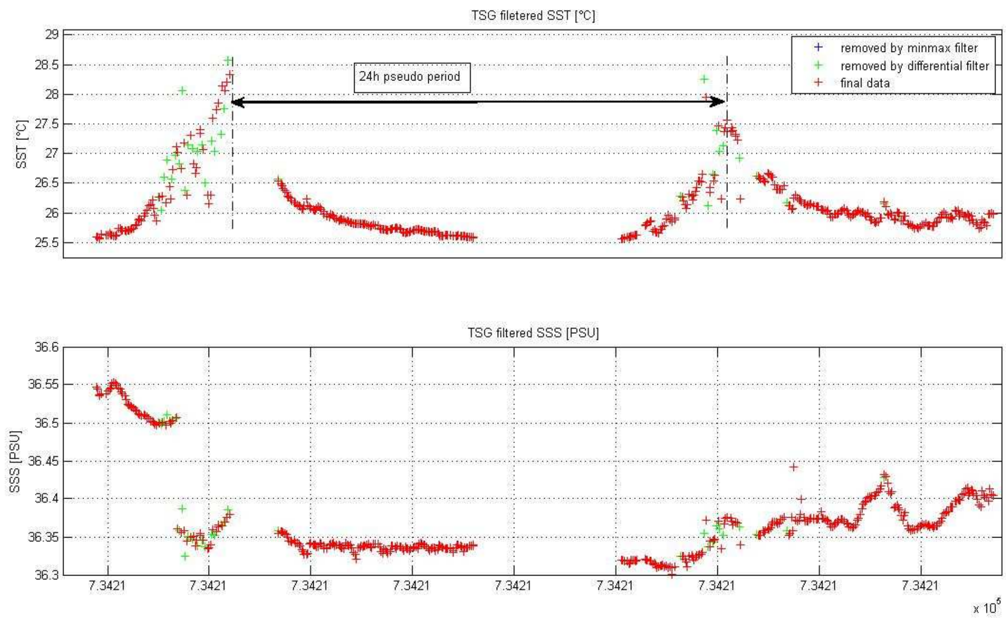


Figure 2 : filtering outliers on SSS and SST time series (zoom on 33 hrs)

Comments on noise
Typically on graph n°2 (Indian Ocean) the diurnal SST signal is physically significant, it is NOT noise (it doesn't affect SSS) and therefore must NOT be removed by the high pass filter .That's why we keep its threshold values at low level.

Noise may be induced by air bubbles in the sea water intake , especially in heavy weather and despite of the vortex debubbler. Visual detection on the time series with manual removal is the only solution.

ACS is *in line and upstream* with the TSG on the seawater duct. Hence the ACS filtered periods (0.2 µ, 5mn every 30mn) apply as well to TSG data: in theory, they shouldn't affect T and C measurements ; but the filter's 1liter content is released into the TSG, which means that at the start of every filtered period, "25mn old " sea water is delivered to TSG during 15s (flowrate 4lt/mn). This periodic noise doesn't show up in the 5mn median averaged data, but should be visible in the 10s raw data and obviously on the new inline fluorometer data for the year 2 process.

IV- TSG Calibration

T1 and C sensors on SBE45 and T2 sensor on SBE38 have been factory calibrated :

- On purchase on 13/may/2009
- On arrival at Capetown on 04/aug/2010

Calibration reports and applied algorithm appear in appendix 3 .

Principle :

- Raw 10s files with T1/C/T2 are no more available due to interface problems on board during 1rst year, we only have access to 5mn averaged SST (T2 from SBE38) and SSS (computed from T1 and C)
- By linear interpolation between calibration dates, we compute C slope and offset on T for the julian date of each data .
- We apply the offset to each SST data
- We apply the slope to each SSS data

Correction values function of time appear on graph n° 3

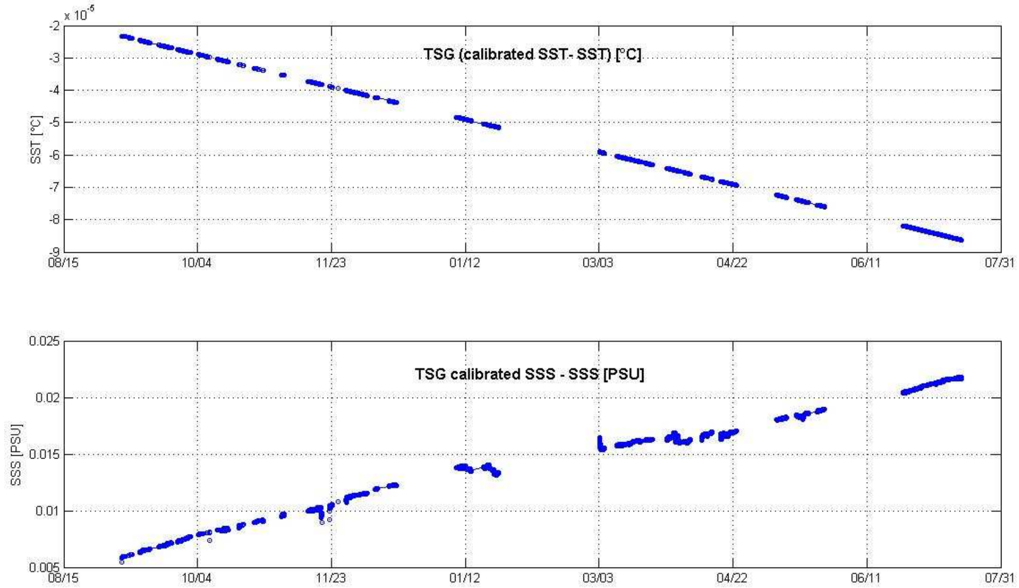


Figure 4 : calibration corrections on SST and SSS during the whole campaign

After one year ,arriving in Capetown , the maximum drifts were :

- 0.00009 °C on SST
+ 0.022 PSU on SSS

Temperature drift is not significant , being less than SBE38 initial accuracy (0.002°C)
Salinity drift is significant , being 4 times the SBE45 initial accuracy (0.005 PSU) .

We estimate (by simulation on raw files) that *correcting salinity instead of conductivity* induces an error less than 0.005PSU.

IV- Inter comparison with CTD profiles

IV-1 Principle

V. Taillandier has processed the 153 CTD downcast profiles , binaveraged to 1m for the Nice - Capetown legs . Data are calibrated and quality controlled , but no salinity bottles have been sampled during this period *[ref 1]*

In each CTD profile :

- We extract T/S data for depth range 1-4m (when available… not always) with their julian date
- We compute spatial averages and stdv.
- For each CTD profile, they are compared to simultaneous TSG data (SST and SSS averaged on a ± 10 mn window around CTD time, graph 4)
- (CTD- TSG)errors on SST and SSS are plotted against time, allowing detection of error trends (graph 5)

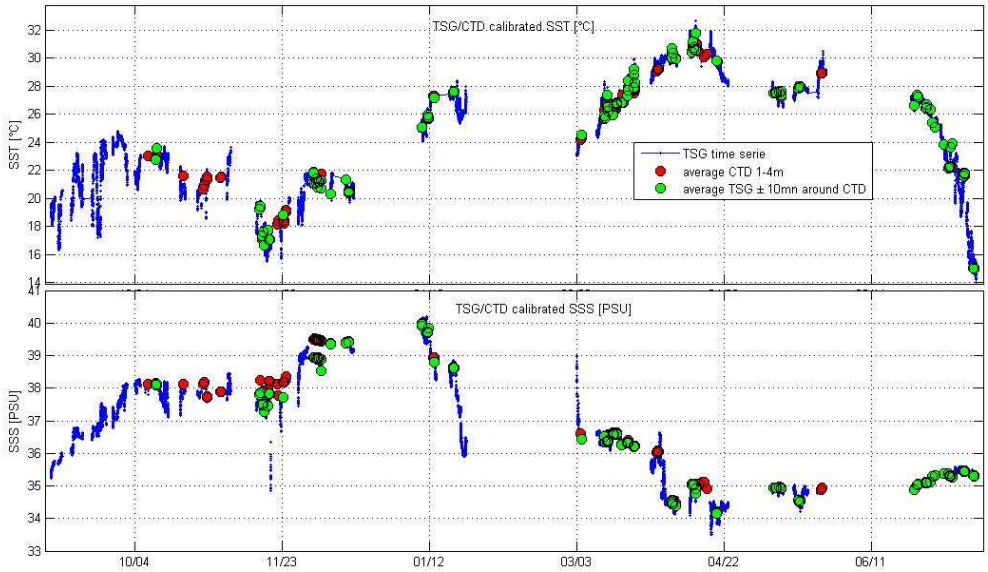


Figure 4 : CTD & TSG SST/SSS on the whole period

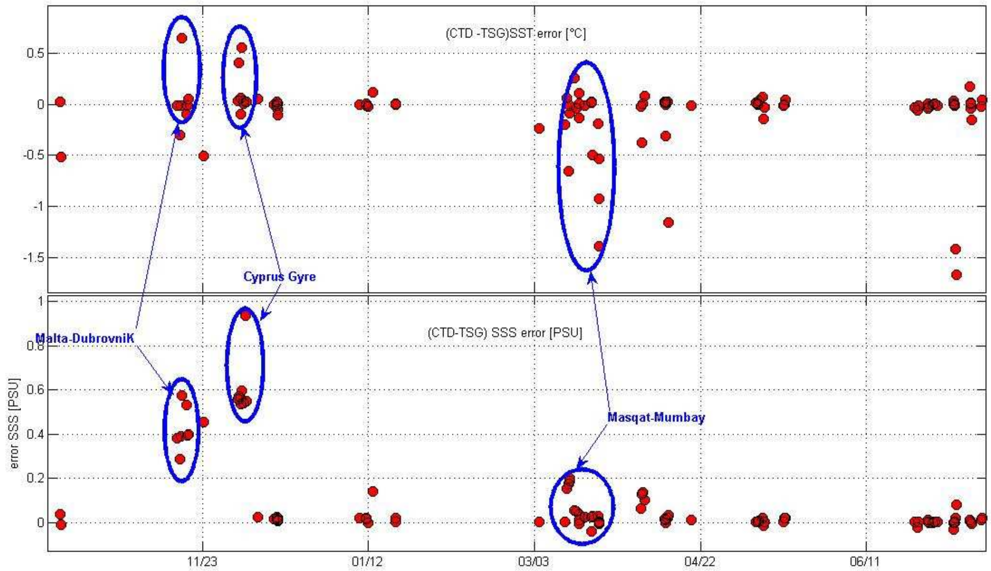


Figure 5 : (CTD-TSG) SST and SSS errors

Comments :

- With a ±10mn time window on TSG and a depth range of 1-4m on CTD , we find 96 comparison points among the 153 CTD profiles .
- Error values are very heterogeneous over the period and may reach 1.5°C and 1 PSU !
- Therefore each individual CTD profile must be carefully studied in order to validate or unvalidate it for TSG corrections .

IV-2 Example on the Cyprus Gyre Leg .

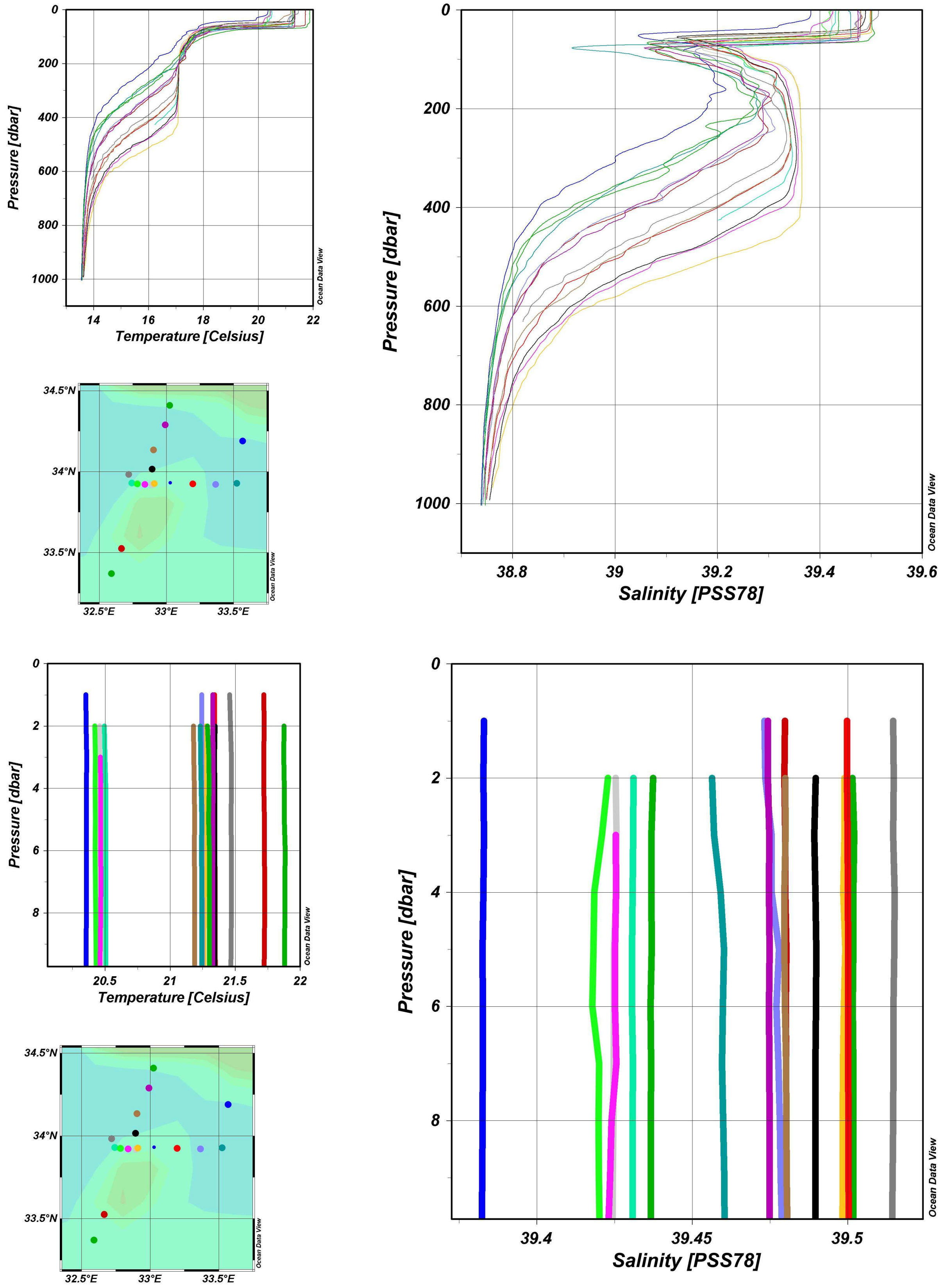
Figure 6 shows the CTD profiles (n°28 to 39), with a well developed mixing layer down to 50m . Zooming into the first 10 meters shows that all profiles give significant data in the 1-4m range . *A priori* we consider all these profiles as valid for CTD/TSG comparison.

Figure 7 shows the comparison and the calculated errors .
All CTD salinities show an average offset of 0.55 PSU with the TSG , except cast n° 29 (0.95 PSU).
All CTD temperature show an average offset less than 0.1°C except casts n° 30, 34 and 29 .
These 3 CTD casts are simultaneous with noisy parts on the TSG time series (turbulence?).
We compute the averaged errors on the leg , *discarding these 3 casts* .

Average SST error = +0.009°C   *Average SSS error = +0.548 PSU* .

We apply these corrections to the TSG data and obtain the corrected time plots on graph n°8.

Figure 6 : CTD stations on Cyprus Gyre Leg



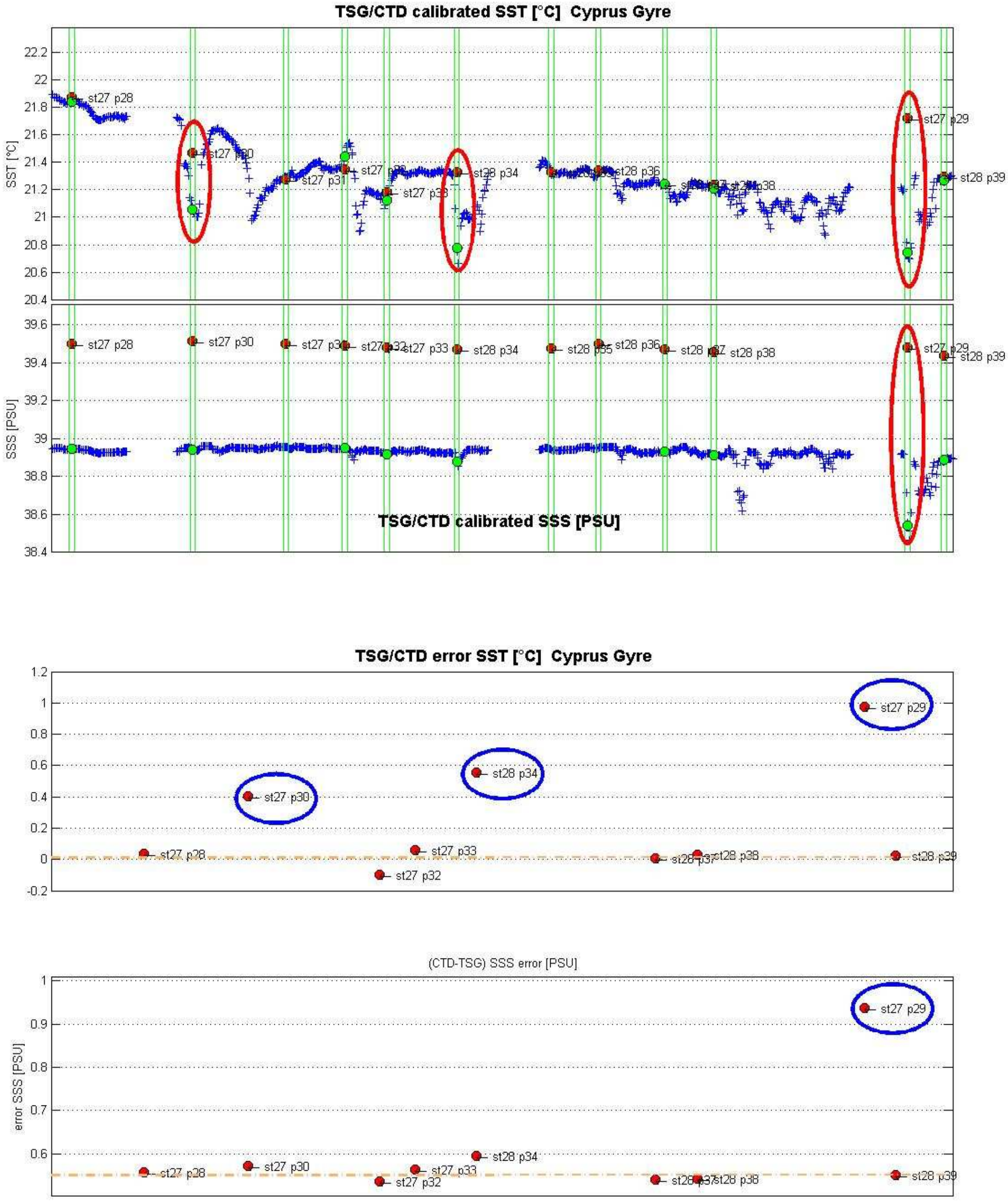


Figure 7 :calibrated SST and SSS before TSG corrections , TSG / CTD time series and errors

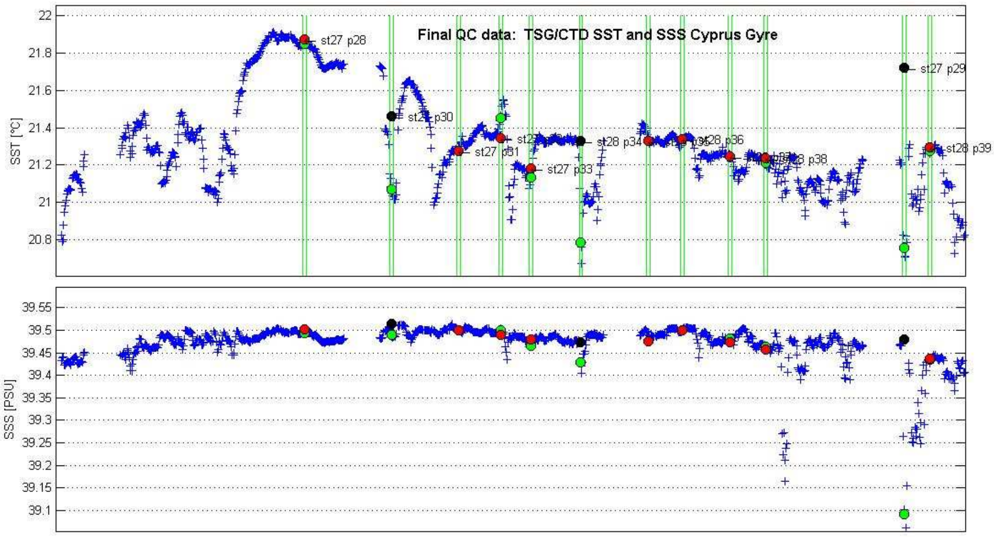


Figure 8 : calibrated SST and SSS after TSG corrections , TSG / CTD time series

IV-4 Corrections for all other legs

A similar processing has been applied to all legs from Nice to Capetown . Corrections values are summarized in appendix 2 .

Valid CTD profiles for TSG corrections have dropped to 89.

Some legs show no corrections on TSG , because no CTD profiles were available :

- from Lorient to Nice , we had no rosette with SBE911 on board but only a small SBE19 standalone , whose data have not been post-processed at LOV .
- from Nice to Malta , the TSG had such random failures that all CTD profiles occurred unluckily during TSG gaps.

Some legs were split into several sessions with various corrections values , due to notably different error patterns (fouling in the TSG sea water intake ?).

Appendix n°2 : CTD stations log sheet with related corrections on TSG data

ODV #stn	Leg	Station	Pressure	CTD Post Proc comments	CTD valid for TSG	corr SST	corr SSS	TSG comments
			(dbar)		*(Y/N)*	*(°C)*	*(PSU)*	
	Lorient-Nice			SBE19 data not processed	N	0,000	0,000	no CTd
0	Nice	1		stopped at datcnv				
1	Nice	2	908	S spikes at thermocline (50m)	N	0,000	0,000	no valid CTd
2	Nice - Bizerte	12	1678	RAS	N	0,000	0,000	no valid CTd
3	Nice - Bizerte	12	275	RAS	N	0,000	0,000	no valid CTd
4	Nice - Bizerte	12	510	bad values in surface bins	N	0,000	0,000	no valid CTd
5	Bizerte - Naples	14	805	RAS	N	0,000	0,000	no valid CTd
6	Naples - Malta	16	210	RAS	N	0,000	0,000	no valid CTd
7	Naples - Malta	16	840	TC1 unstable at 220m, TC2 at 360m	N	0,000	0,000	no valid CTd
8	Naples - Malta	16	410	RAS	N	0,000	0,000	no valid CTd
9	Naples - Malta	17	205	RAS	N	0,000	0,000	no valid CTd
10	Naples - Malta	17	265	RAS	N	0,000	0,000	no valid CTd
11	Malta - Malta	18	225	RAS	N	0,000	0,000	no valid CTd
12	Malta - Malta	18	740	S spikes at thermocline (60m)	N	0,000	0,000	no valid CTd
13	Malta - Dubrovnik	21	900	S spikes at thermocline (60m)	N	0,003	0,392	
14	Malta - Dubrovnik	21	430	S spikes at thermocline (60m)	Y	0,003	0,392	
15	Malta - Dubrovnik	22	210	RAS	Y	0,003	0,392	
16	Malta - Dubrovnik	22	740	layered in 0-100m	Y	0,003	0,392	
17	Malta - Dubrovnik	22	205	RAS	N	0,003	0,392	
18	Malta - Dubrovnik	23	203	low S in 0-20m	N	0,003	0,392	
19	Malta - Dubrovnik	23	460	RAS	Y	0,003	0,392	
20	Malta - Dubrovnik	23	203	TC1 unstable at 160m	Y	0,003	0,392	
21	Dubrovnik - Dubrovnik	24	285	RAS	N			no TSG
22	Dubrovnik - Dubrovnik	24	255	RAS	N			no TSG
23	Dubrovnik - Athens	25	212	RAS	Y	-0,065	0,455	TSG unreliable
24	Dubrovnik - Athens	25	970	RAS	N	-0,065	0,455	TSG unreliable
25	Dubrovnik - Athens	25	206	RAS	N	-0,065	0,455	TSG unreliable
26	Dubrovnik - Athens	26	205	S spikes at thermocline (50m)	N	-0,065	0,455	TSG unreliable
27	Dubrovnik - Athens	26	480	S spikes at thermocline (50m)	N	-0,065	0,455	TSG unreliable
28	Athens - Beyruth	27	882	S spikes at thermocline (80m)	Y	0,009	0,548	
29	Athens - Beyruth	27	950	S spikes at thermocline (80m)	N	0,009	0,548	
30	Athens - Beyruth	27	632	S spikes at thermocline (80m)	N	0,009	0,548	
	Athens - Beyruth	27	330	pressure data corrupted	N	0,009	0,548	
31	Athens - Beyruth	27	967	S spikes at thermocline (80m)	Y	0,009	0,548	
32	Athens - Beyruth	27	993	S spikes at thermocline (80m)	Y	0,009	0,548	
33	Athens - Beyruth	27	992	S spikes at thermocline (80m)	Y	0,009	0,548	
34	Athens - Beyruth	28	987	S spikes at thermocline (80m)	N	0,009	0,548	
35	Athens - Beyruth	28	1006	bad values in surface bins	Y	0,009	0,548	
36	Athens - Beyruth	28	981	S spikes at thermocline (80m)	Y	0,009	0,548	
37	Athens - Beyruth	28	999	S more spiky	Y	0,009	0,548	
38	Athens - Beyruth	28	1004	S spikes at thermocline (80m)	Y	0,009	0,548	
39	Cyprus - Beyruth	28	1004	S more spiky	Y	0,009	0,548	
40	Cyprus - Beyruth	28	1004	S more spiky	N	0,023	0,053	
41	Beyruth - Alexandrie	29	972	S spikes at thermocline (140m)	Y	-0,035	0,017	

42	Beyruth - Alexandrie	30	196	RAS	Y	-0,035	0,017	
43	Beyruth - Alexandrie	30	992	S spikes at thermocline (80m)	Y	-0,035	0,017	
44	Beyruth - Alexandrie	30	135	RAS	Y	-0,035	0,017	
45	Beyruth - Alexandrie	30	126	RAS	N	-0,035	0,017	
46	Beyruth - Alexandrie	30	120	RAS	Y	-0,035	0,017	
47	Beyruth - Alexandrie	30	426	S spikes at thermocline (80m)	Y	-0,035	0,017	
48	Sharm - Jeddah1	31	298	RAS	Y	0,011	0,040	
49	Sharm - Jeddah1	31	886	RAS	N	0,011	0,040	
50	Sharm - Jeddah1	32	219	RAS	Y	0,011	0,040	
51	Sharm - Jeddah1	32	952	RAS	Y	0,011	0,040	
52	Sharm - Jeddah1	32	208	RAS	Y	0,011	0,040	
53	Sharm - Jeddah1	33	155	RAS	N	0,011	0,040	
54	Sharm - Jeddah1	33	640	RAS	N	0,011	0,012	
55	Sharm - Jeddah2	34	203	RAS	Y	0,002	0,012	
56	Sharm - Jeddah2	34	982	RAS	Y	0,002	0,012	
	Sharm - Jeddah	34		pressure data corrupted	N	0,000	0,012	
57	AbuDhabi-Masqat	36	309	RAS	Y	-0,118	0,012	
58	AbuDhabi-Masqat	36	866	layered until 400m	Y	-0,118	0,012	
59	AbuDhabi-Masqat	36	932	layered until 400m	Y	-0,118	0,012	
60	Masqat-Mumbay1	36	1011	TC1 bad profile	N	-0,019	0,180	
61	Masqat-Mumbay1	36	300	RAS	N	-0,019	0,180	
62	Masqat-Mumbay1	36	668	diff characteristics in deep layer (60-62)	Y	-0,019	0,180	
	Masqat-Mumbay1	37	213	bad profile		-0,019	0,180	
63	Masqat-Mumbay1	37	702	surface layer missing (0-50m)	Y	-0,019	0,180	
64	Masqat-Mumbay1	37	741	TC1 bad profile	N	-0,019	0,180	
65	Masqat-Mumbay1	37	739	RAS	Y	-0,019	0,180	
66	Masqat-Mumbay1	37	736	C1 lost 0.05 PSU in 200-600m	Y	-0,019	0,180	
67	Masqat-Mumbay1	37	1512	RAS	Y	-0,019	0,180	
68	Masqat-Mumbay2	38	1011	layered in 0-100m	Y	-0,082	0,030	
69	Masqat-Mumbay2	38	296	layered in 0-100m	N	-0,082	0,030	
70	Masqat-Mumbay2	38	295	TC1 and TC2 unstable in 0-50m	N	-0,082	0,030	
71	Masqat-Mumbay2	38	1003	layered in 0-100m	Y	-0,082	0,030	
72	Masqat-Mumbay2	38	489	layered in 0-100m	N	-0,082	0,030	
73	Masqat-Mumbay2	38	481	layered in 0-100m	N	-0,082	0,030	
	Masqat-Mumbay2	38	500	stopped at datcnv	N	-0,082	0,030	
74	Masqat-Mumbay2	38	475	layered in 0-100m	Y	-0,082	0,030	
75	Masqat-Mumbay2	38	474	layered in 0-100m	Y	-0,082	0,030	
76	Masqat-Mumbay2	38	479	RAS	N	-0,082	0,030	
77	Masqat-Mumbay2	38	485	RAS	N	-0,082	0,030	
78	Masqat-Mumbay2	38	1489	RAS	Y	-0,082	0,030	
79	Masqat-Mumbay2	39	997	short layers in thermocline (front?)	Y	-0,082	0,030	
80	Masqat-Mumbay2	39	485	RAS	N	-0,082	0,030	
81	Masqat-Mumbay2	39	1476	RAS	N	-0,082	0,012	
82	Masqat-Mumbay2	39	1000	layered in 0-200m	Y	-0,082	0,012	
83	Masqat-Mumbay2	39	502	layered in 0-200m	N	-0,082	0,012	TSG spikes during CTDs
84	Masqat-Mumbay2	39	493	layered in 0-200m	N	-0,082	0,012	TSG spikes during CTDs
85	Masqat-Mumbay2	39	489	smoother than previous profiles	N	-0,082	0,012	TSG spikes during CTDs
86	Masqat-Mumbay2	39	487	slight differences between C1 and C2	N	-0,082	0,012	TSG spikes during CTDs

	Masqat-Mumbay3	39	1000	pressure data corrupted	N	-0,093	0,012	TSG spikes during CTDs
	Masqat-Mumbay3	39	500	pressure data corrupted	N	-0,093	0,012	TSG spikes during CTDs
87	Masqat-Mumbay3	40	1445	layered until 400m	N	-0,093	0,012	TSG spikes during CTDs
88	Masqat-Mumbay3	40	486	layered until 400m	Y	-0,093	0,012	
89	Masqat-Mumbay3	40	497	layered until 400m	Y	-0,093	0,012	
90	Masqat-Mumbay3	40	498	layered until 400m	Y	-0,093	0,012	
91	Masqat-Mumbay3	40	497	layered until 400m	Y	-0,093	0,012	
92	Masqat-Mumbay3	40	494	smoother than previous profiles	N	-0,093	0,012	
93	Mumbay-Male	41	973	RAS	N	-0,120	0,109	
94	Mumbay-Male	41	489	RAS	N	-0,120	0,109	
95	Mumbay-Male	41	492	RAS	N	-0,120	0,109	
96	Mumbay-Male	41	1495	RAS	N	-0,120	0,109	
97	Mumbay-Male	42	1007	S spikes at thermocline (100m)	Y	-0,120	0,109	
98	Mumbay-Male	42	503	S spikes at thermocline (100m)	Y	-0,120	0,109	
99	Mumbay-Male	42	1512	S spikes at thermocline (100m)	Y	-0,120	0,109	
100	Mumbay-Male	43	51	RAS	Y	-0,120	0,109	
101	Male-StBrandon	44	1003	S spikes at thermocline (80m)	Y	0,022	0,013	
102	Male-StBrandon	44	505	S spikes at thermocline (80m)	Y	0,022	0,013	
	Male-StBrandon	44	14	only soak	N	0,022		
103	Male-StBrandon	44	270	S spikes at thermocline (80m)	Y	0,022	0,013	
104	Male-StBrandon	44	270	S spikes at thermocline (80m)	Y	0,022	0,013	
105	Male-StBrandon	44	980	C1 unstable under 800m	Y	0,022	0,013	
106	Male-StBrandon	45	506	layered until 150m	Y	0,022	0,013	
107	Male-StBrandon	45	504	layered until 150m	N	0,022	0,013	
108	Male-StBrandon	45	503	layered until 150m	N	0,022	0,013	
109	Male-StBrandon	45	500	smoother than previous profiles	N	0,022	0,013	
110	Male-StBrandon	45	495	smoother than previous profiles	N	0,022	0,013	
111	Male-StBrandon	45	890	RAS	N	0,022	0,013	
112	Male-StBrandon	46	65,5	RAS	N	0,022	0,013	
113	Male-StBrandon	47	955	RAS	N	0,022	0,013	
114	Male-StBrandon	48	877	RAS	Y	0,022	0,013	
115	Male-StBrandon	48	485	RAS	N	0,022	0,013	
116	Male-StBrandon	48	482	RAS	N	0,022	0,013	
	Male-StBrandon	49	9	only soak				
117	Mauritius-Reunion	50	1404	RAS	Y	0,004	0,005	
118	Mauritius-Reunion	50	982	RAS	Y	0,004	0,005	
119	Mauritius-Reunion	50	533	RAS	Y	0,004	0,005	
120	Mauritius-Reunion	50	194	RAS	Y	0,004	0,005	
121	Mauritius-Reunion	50	205	RAS	Y	0,004	0,005	
122	Mauritius-Reunion	51	1360	RAS	N	0,004	0,005	
123	Mauritius-Reunion	51	1050	RAS	N	0,004	0,005	
124	Mauritius-Reunion	51	240	RAS	Y	0,004	0,005	
125	Reunion-Madagascar	52	1474	RAS	Y	0,005	0,009	
126	Reunion-Madagascar	52	231	RAS	Y	0,005	0,009	
127	Reunion-Madagascar	52	489	RAS	N	0,005	0,009	
128	Madagascar-Mayotte	53	1515	RAS	Y	0,005	0,009	
129	Madagascar-Mayotte	53	994	RAS	Y	0,005	0,009	
	Madagascar-Mayotte	54	25	profile 0-25m without soak	N			
	Madagascar-	54	25	profile 0-25m without soak	N			

	Mayotte							
130	Mayotte-CapeTown1	55	1143	S spikes at thermocline (60m)	Y	-0,010	0,003	
131	Mayotte-CapeTown1	56	1262	S spikes at thermocline (90m)	N	-0,010	0,003	
132	Mayotte-CapeTown1	57	1009	S spikes at thermocline (90m)	Y	-0,010	0,003	
133	Mayotte-CapeTown1	58	1482	bad values of C1 in surface bins	Y	-0,010	0,003	
134	Mayotte-CapeTown1	58	1254	RAS	Y	-0,010	0,003	
135	Mayotte-CapeTown1	58	367	RAS	Y	-0,010	0,003	
136	Mayotte-CapeTown1	58	1018	RAS	Y	-0,010	0,003	
137	Mayotte-CapeTown1	59	957	S spikes at thermocline (60m)	Y	-0,010	0,003	
138	Mayotte-CapeTown1	60	924	S spikes at thermocline (80m)	Y	-0,010	0,003	
139	Mayotte-CapeTown1	61	942	spike at 600m on both TC	Y	-0,010	0,003	
140	Mayotte-CapeTown1	63	867	RAS	Y	-0,010	0,003	
141	Mayotte-CapeTown1	64	1533	RAS	N	-0,010	0,003	
142	Mayotte-CapeTown1	64	319?	RAS	Y	-0,010	0,003	
143	Mayotte-CapeTown1	64	1193	RAS	Y	-0,010	0,003	
144	Mayotte-CapeTown1	64	1213	RAS	Y	-0,010	0,003	
145	Mayotte-CapeTown2	64	1006	RAS	N	-0,007	0,003	
146	Mayotte-CapeTown2	64	489	layered at 175m	N	-0,007	0,003	
147	Mayotte-CapeTown2	65	1241	layered between 100-150m	N	-0,007	0,003	
148	Mayotte-CapeTown2	65	68	RAS	Y	-0,007	0,003	
149	Mayotte-CapeTown2	65	68	RAS	Y	-0,007	0,003	
150	Mayotte-CapeTown2	65	1138	RAS	Y	-0,007	0,003	
151	Mayotte-CapeTown2	65	1073	RAS	N	-0,007	0,003	
152	Mayotte-CapeTown3	66	456	RAS	Y	0,009	0,016	
	Mayotte-CapeTown3	66	68	bad profile, in stairs	N	0,009	0,016	
	Mayotte-CapeTown3	66	70	bad profile, in stairs	N	0,009	0,016	
153	Mayotte-CapeTown3	66	1259	RAS	Y	0,009	0,016	

Appendix 3 : Calibration Coefficients for TSG SBE45 and SST probe SBE38

Algorithm :

```
%declare calibrations:
 time1=datenum('05/13/2009') % precruise calibration date
time2=datenum('08/04/2010') % postcruise calibration date

dtime=time2-time1
ps= 0.9993577  %postcruise slope
DT= 0.00009    % postcruise delta T

% compute linear regression on C slope: slope(x)= 1- alpha*x
%x is number of elapsed days since precalibration
% Ctrue= Ctsg * slope
% Strue= Stsg*slope  ***BY APPROXIMATION***
alpha= (ps-1)/dtime

% compute linear regression on T offset : R(x)=  beta*x
%x is number of elapsed days since precalibration
% Ttrue= Ttsg- R(x)
beta=DT/dtime
```

SEA-BIRD ELECTRONICS, INC.
13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA
Phone (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0497
CALIBRATION DATE: 04-Aug-10

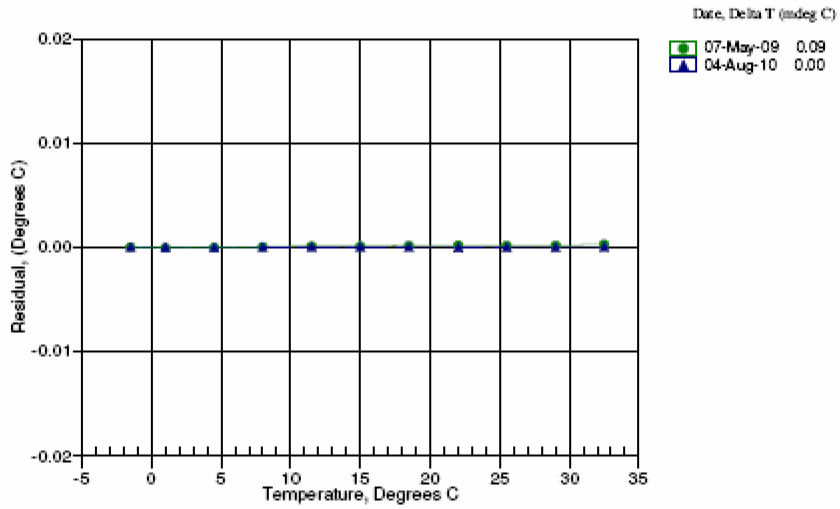
SBE 38 TEMPERATURE CALIBRATION DATA
ITS-90 TEMPERATURE SCALE

ITS-90 COEFFICIENTS
a0 = 5.380128e-005
a1 = 2.680911e-004
a2 = -2.030259e-006
a3 = 1.393794e-007

BATH TEMP (ITS-90)	INSTRUMENT OUTPUT	INST TEMP (ITS-90)	RESIDUAL (ITS-90)
-1.50000	823760.5	-1.49999	0.00001
1.00000	733701.2	0.99999	-0.00001
4.50000	625762.3	4.49996	-0.00004
8.00000	535496.8	8.00001	0.00001
11.50000	459750.0	11.50001	0.00001
15.00000	395969.7	15.00001	0.00001
18.50000	342088.2	18.50002	0.00002
22.00000	296423.6	21.99998	-0.00002
25.50000	257601.1	25.49999	-0.00001
29.00000	224496.0	28.99999	-0.00001
32.50000	196182.7	32.50001	0.00001

Temperature ITS-90 = $1/\{a0 + a1[ln(n)] + a2[ln^2(n)] + a3[ln^3(n)]\} - 273.15$ (°C)

Residual = instrument temperature - bath temperature



SEA-BIRD ELECTRONICS, INC.

13431 NE 20th Street, Bellevue, Washington, 98005-2010 USA

Phone: (425) 643 - 9866 Fax (425) 643 - 9954 Email: seabird@seabird.com

SENSOR SERIAL NUMBER: 0286
CALIBRATION DATE: 04-Aug-10

SBE 45 CONDUCTIVITY CALIBRATION DATA
PSS 1978: C(35,15,0) = 4.2914 Siemens/meter

COEFFICIENTS:

g = -1.014235e+000
h = 1.592542e-001
i = -1.737253e-004
j = 4.064979e-005

CPcor = -9.5700e-008
CTcor = 3.2500e-006
WBOTC = 2.6402e-007

BATH TEMP (ITS-90)	BATH SAL (PSU)	BATH COND (Siemens/m)	INST FREQ (Hz)	INST COND (Siemens/m)	RESIDUAL (Siemens/m)
22.0000	0.0000	0.00000	2525.04	0.00000	0.00000
1.0000	34.6592	2.96381	4995.62	2.96380	-0.00001
4.4999	34.6398	3.26970	5183.44	3.26971	0.00001
15.0000	34.5973	4.24758	5742.00	4.24758	0.00000
18.5000	34.5879	4.59133	5925.59	4.59132	-0.00000
24.0000	34.5769	5.14694	6210.59	5.14693	-0.00001
29.0000	34.5699	5.66649	6465.44	5.66650	0.00001
32.5000	34.5652	6.03714	6641.09	6.03713	-0.00001

f = INST FREQ * sqrt(1.0 + WBOTC * t) / 1000.0

Conductivity = $(g + hf^2 + if^3 + jf^4) / (1 + \delta t + \epsilon p)$ Siemens/meter

t = temperature[°C)]; p = pressure[decibars]; δ = CTcor; ϵ = CPcor;

Residual = instrument conductivity - bath conductivity