Delayed-mode Argo Data Intercomparison

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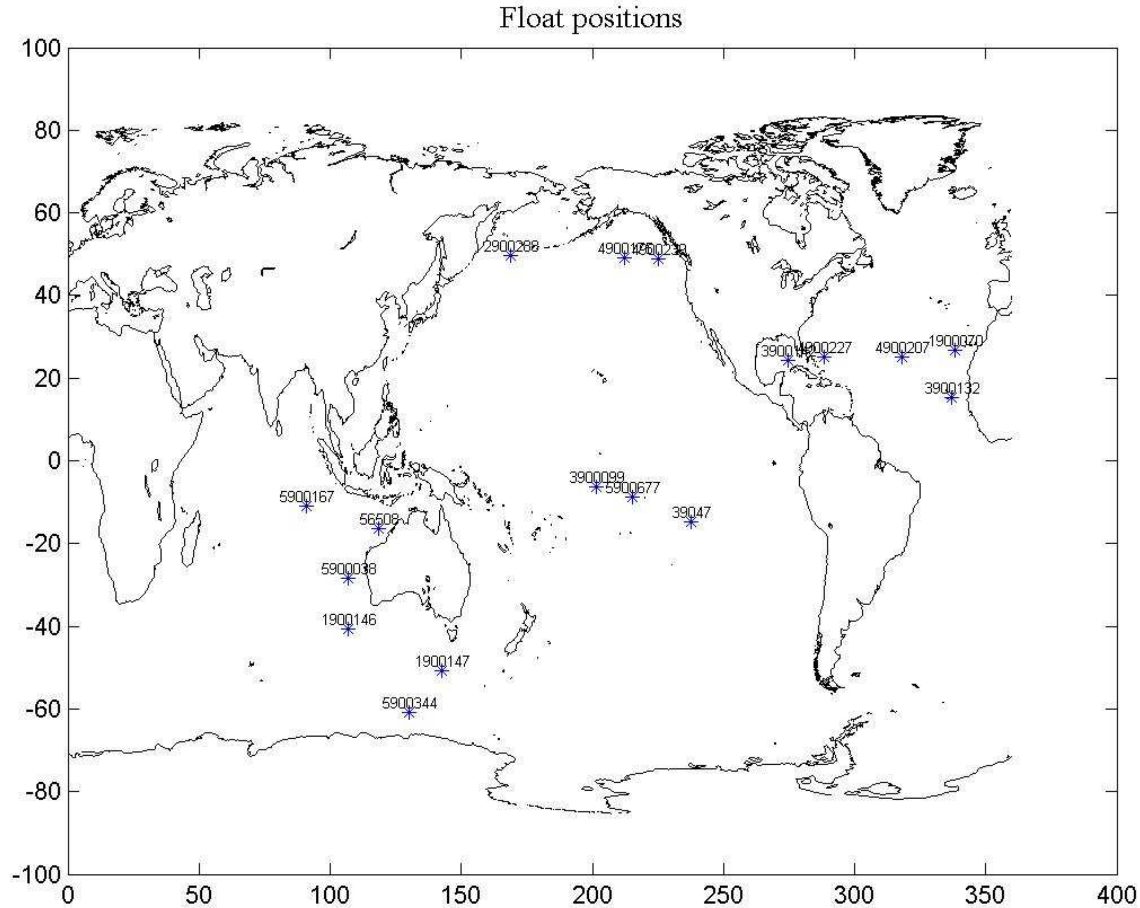
Background
The aim of this intercomparison is to assess differences in approaches to the delayed-mode quality-control (DMWC) of Argo data between the various Argo National Data Centers (DACs) and to flag areas where more consistency might be achieved or where discrepancies exist. To compare methods, a common set of Argo float data sets underwent DMQC by several national groups and the resulting QC'd and adjusted data were analysed. This activity resulted from discussions at AST-7 in India, where concern was growing that divergent practices where developing with regard to DMQC.

Methods

An invitation was sent to Argo PIs on February 2006. Eight Argo teams expressed an interest in participating to the exercise (IFM-Geomar, Ifremer, Jamstec, MEDS, PMEL, SIO, University of Washington and CSIRO). Each participating team nominated two to three floats to be used as a basis of intercomparison. The proposal was to group the chosen floats between those requiring large adjustments and those requiring only marginal ones. Another criterion was ocean coverage with a balanced geographical distribution.

A total of 17 floats were selected, four from the Indian Ocean, two from the Southern Ocean, six from North and South Pacific and five from the Atlantic. Figure 1 shows the geographical distribution of these floats. Real-time netcdf files were supplied by CSIRO to the DACs to analyse. However, some DACs sourced the data from the GDACs rather than the distributed files, and, surprisingly, for some floats the R/T files were quite different (e.g. 3900132,3900142), complicating the intercomparison.



The profiles of the floats were put through delayed-mode quality control and the processed data returned to CSIRO. Table 1 shows the WMO numbers of the floats chosen for the intercomparison. Profiles in Table 1 were processed using the reference data in WOD 2001 as provided by WJO. Profiles in Table 2 were processed using additional reference data available to individual groups.

wmo_id	**ifmgeomar**	**ifremer**	**jamstec**
1900070	NA	X	X
1900146	NA	X	X
1900147	NA	X	X
2900288	NA	X	X
3900099	NA	X	X
3900132	X	X	X
3900142	X	X	X
39047	NA	X	X
4900175	NA	X	X

4900207	NA	X	X
4900227	NA	X	X
4900239	NA	X	X
56508	NA	X	X
5900038	NA	X	X
5900167	NA	NA	X
5900344	NA	X	X
5900677	NA	X	X

Table 1. Profiles processed using WOD 2001 reference data base.

wmo_id	ifmgeomar	ifremer	jamstec	meds	pmel	sio	uw
1900070	X	X	NA	X	X	X	X
1900146	X	X	X	X	NA	X	X
1900147	X	X	X	X	NA	X	X
2900288	X	X	X	X	X	X	NA
3900099	X	X	X	X	NA	X	X
3900132	X	X	NA	X	NA	X	NA
3900142	X	X	NA	X	NA	X	NA
39047	X	X	X	X	NA	X	NA
4900175	X	X	X	X	X	X	NA
4900207	X	X	NA	X	X	X	X
4900227	X	X	NA	X	NA	NA	NA
4900239	X	X	X	X	X	X	NA
56508	X	X	X	X	NA	X	NA
5900038	NA	X	X	NA	X	X	NA
5900167	NA	NA	X	X	NA	NA	X
5900344	X	X	X	X	NA	X	NA
5900677	X	X	X	X	NA	X	NA

Table 2. Profiles processed using WOD 2001 plus other additional reference data.

Two aspects of DMQC were scrutinized: the QC flags assigned to the float and the salinity adjustments made (and their associated error bars) where the salinity sensor was deemed to have drifted. Several returned data sets contained spikes or huge and unrealistic adjustments which we assumed to have resulted from programming errors. These were ignored in the main analysis.

The QC flags are plotted in a matrix colour plot of profile number and observation number for both the raw salinity field and the adjusted salinity field, which allows for easy visual comparison. These are reported in Appendix 2, and commented on in detail in the float commentaries.

Salinity adjustments are presented as the mean over a profile of the raw – adjusted salinities for values where the adjusted salinity QC =1 or 2. Where the conductivity ratio method has been used to make the salinity adjustment, there is a slight temperature dependence of the salinity adjustment, and where a thermal lag correction has been applied, salinity adjustments are larger where temperature gradients are large. Generally, though, our method allows easy comparison of the profile average differences between the raw data and climatology. In examining the float sensor behaviour, we used two climatologies in our analysis – the Gouretski and Kolterman (1999), which is an isopycnally-averaged gridded data set based on quality-controlled and adjusted historical and WOCE data, and the CSIRO Atlas of Regional Seas (CARS) – a depth-averaged gridded data set quality-controlled and mapped as specified by Dunn and Ridgway (2002).

Results and Recommendations

A commentary for each float makes up the bulk of the report, but an overall summary is presented below as well as the primary recommendations and issues raised by the intercomparison.

Assignment of Quality Flags:

We found a surprising diversity of approaches to the assignment of quality flags to the real-time and delayed-mode data. As the automated real-time data quality checks are only designed to capture gross data errors, the first step in DMQC should be to revisit these flags for adjustment or validation, and check for spiking or other problems the automated checks failed to capture before passing the profiles onto thermal-lag correction and salinity drift analysis.

Some DACs automatically flag all inversions as bad data, even though they are likely somewhat recoverable with a thermal-lag correction.

Some DACs did not revisit the original QC flags before continuing on to DMQC, which meant that some bad data passed through to the adjusted fields, and in several cases, good data flagged bad by the real-time tests was lost in the adjusted fields. Examples are for float 1900070, 39000132 (see plots in Appendix 2), 39047, and 1900070. IFMGEOMAR was the only DAC that set QC=5 on salinities that it adjusted.

Most DACs followed Argo data policy of preserving the R/T QC flags on the raw fields and editing the QC flags in the adjusted fields. This practice may be strategically impractical in the long-term, as future efforts (say by an RDAC or scientist) to revisit the adjusted fields will have to disentangle QC changes associated with poor R/T QC screening and QC flags associated with the quality of drift adjustments/thermal lag adjustments. Should we consider changing the raw QC flags in DMQC so that this man-power intensive component is made distinct from the other DMQC adjustments – thermal-lag and drift assessment?

IFMGEOMAR set QC=5 on all salinities that are adjusted, and is the only DAC to take this approach. This inconsistency between DACs will be confusing for users, and a clear policy must be agreed to. It would be useful for users if there were a clear means to distinguish salinity records that have been substantially adjusted for a drifting sensors (versus the much smaller thermal lag and pressure offset corrections) and a QC=5 value might be one means to do this.

Salinity Drift Estimates:

Ignoring what are clearly programming errors where whole profiles of salinity are offset by unrealistic amounts (or thermal-lag software has not skipped over missing values properly), we found that there is a near-convergence by DACS on drift adjustments. The biggest discrepancies occurred around sudden calibration jumps (eg 39047) where those groups using a large time-window in estimating drifts could not model the sudden calibration changes. However, several examples are included where a smooth calibration change is clearly a better model of sensor changes.

Cases also exist where ocean variability has been interpreted as drift and the data needlessly adjusted.

Overall, adjustments came close to agreeing within the formal error bars, but did not quite reach this optimum state. This may suggest that our errors bars are too small and we should consider increasing their size to reflect the subjective nature of the adjustments being currently made in DMQC.

Floats that park at shallow depths traverse large distances quickly and this makes distinguishing sensor error from natural variability quite difficult.

In the sections for salinity drift comparative analysis, the differences between raw and adjusted salinity values were first calculated for each individual float and each group, then comparison was made between the results obtained by the different groups.

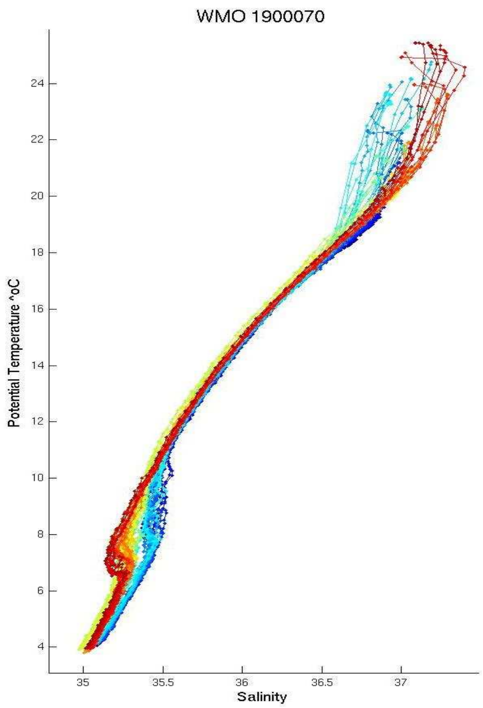
In the series of comparative plots summarising these differences, the x-axis represents the cycle numbers and the y-axis represents the median values of the raw to adjusted salinity differences in psu. In the figures for salinity anomalies mapped to potential temperature surfaces, the bottom plot shows the deepest salinity sampled 90% of time vs the climatologies.

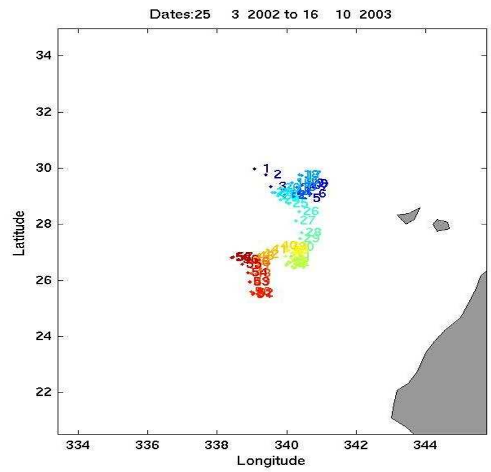
Individual Float Commentary

WMO 1900070

Coriolis Provor Yves Desaubies

Park 1500, profile 2000

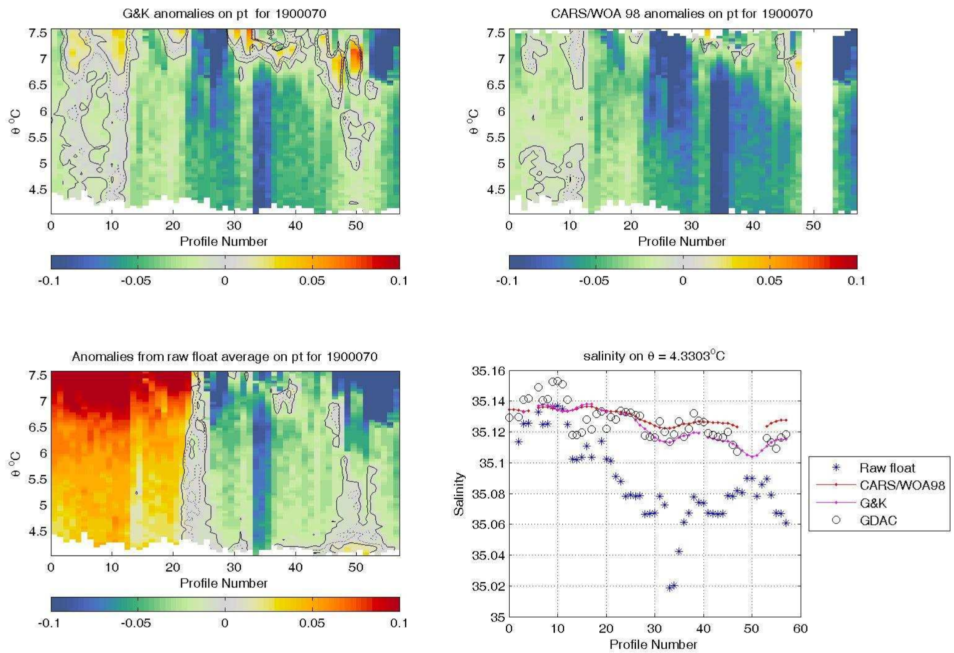




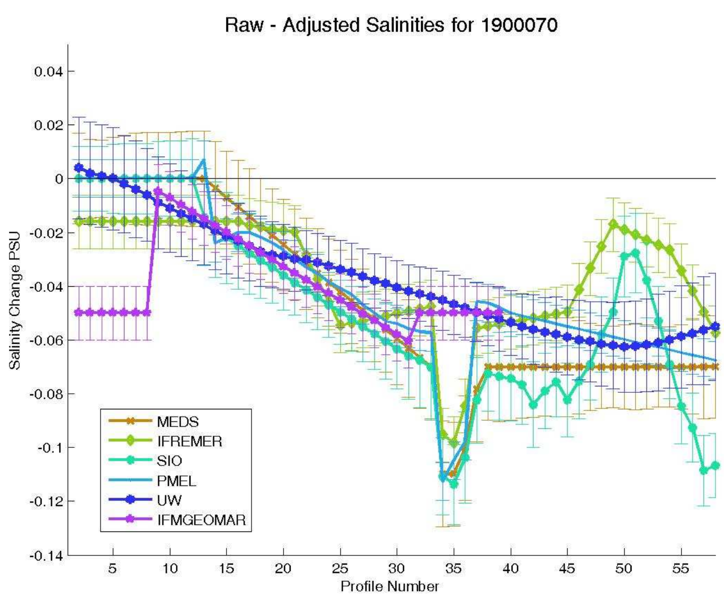
This float is drifting near the Meditteranean Outflow and so the deep T-S relationship is not very stable near 800m – 1500m (6-10°C).

QC Flagging:
Small inversions are found in the mixed layer but are also common at depths near 1500m associated with lots of mid-depth fine scale due to the Meditteranean Outflow. Most DACs left these QC=1, except SIO which seems to have set nearly all inversions to QC=4 in the adjusted salinity field.

Salinity Drift:
Compared to climatology, deep salinity values drifted fresh and then underwent a jump to even fresher values at profile 33 which was evident through much of the bottom half of the profile(see Figure below).



All DACs adjusted salinities for this float and recognized the fresh bias. However the bias jump near profile 33 was only modeled well by a subset of DACs and the smooth-window technique (JAMSTEC and UW) did not capture the jump in the bias at all. Two DACs also reduced the bias near profile 50, where the rest kept the bias near constant. When salinity anomalies are examined compared to the G&K climatology and referenced to the float average, this bias change is less compelling as it is not expressed at all deep temperatures. Could this express an over-reliance on deep temperature data in calculating the bias?

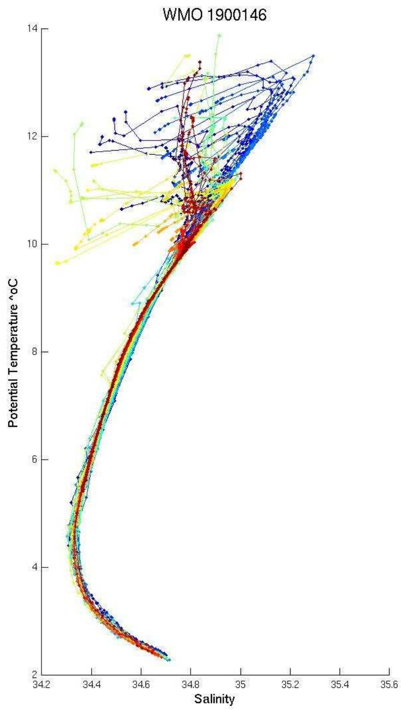


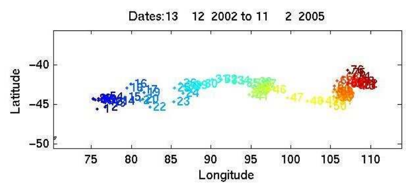
Conclusion. This float showed that the smooth window approach can fail to detect a significant fresh drift. It also indicated the importance of testing the measurements against high quality climatologies. In this instance, a piecewise approach produced adjustments that were more precise and correlating well with the local climatology. However, a salty adjustment of 0.06 psu up to cycle 7 applied by IFM-Geomar appeared difficult to justify.

WMO 1900146

AOML APEX_SBE Stephen Riser

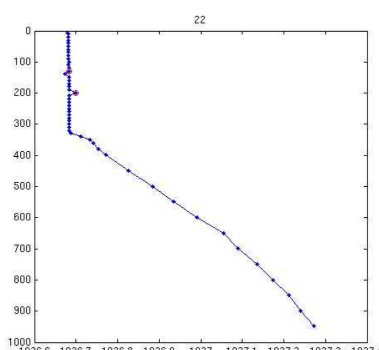
Park 1000, profile 1000

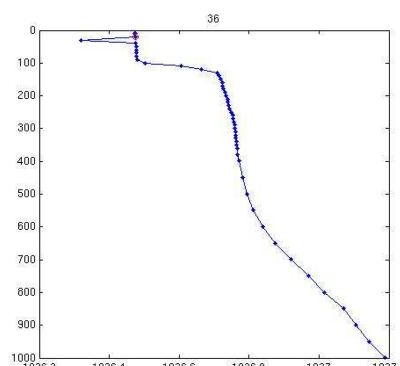




Long-lived APEX profiling to 2000db every 4th profile in the eastern South. Indian Ocean.

QC Flagging:

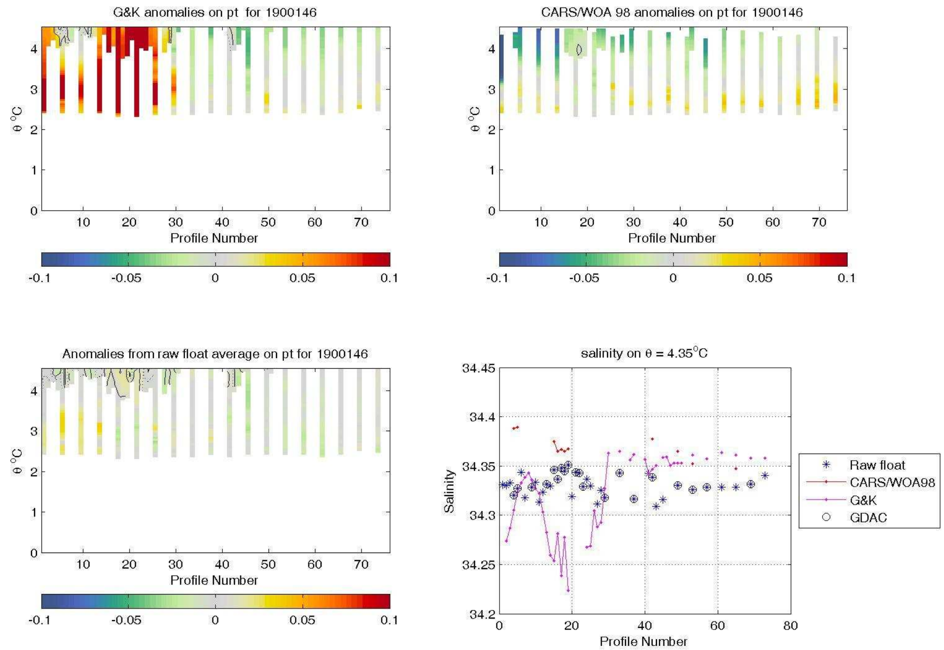


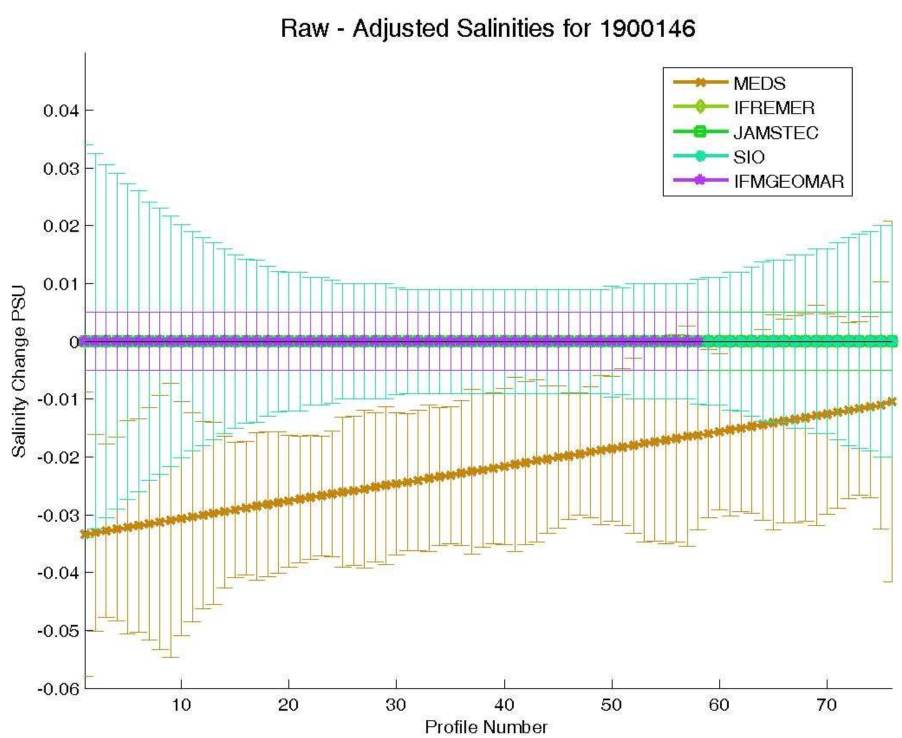


Small inversions were found on profile 22 and a large inversion in the mixed layer on profile 36. Raw data had QC = 2 on S on several profiles: 6,7,8,9,10,11,20,21,51 22 - these were good data and should have QC reverted to 1. Where DACS did re-examine the R/T flags (IFREMER,SIO,UW), they implemented these changes in the adjusted fields.

Salinity Drift:

No clear drift away from climatology is seen on this float, and deep salinities on temperature surfaces are quite stable. Most DACs did not adjust the salinity, except for MEDs which calculated a salty bias in the sensor which is difficult to understand.



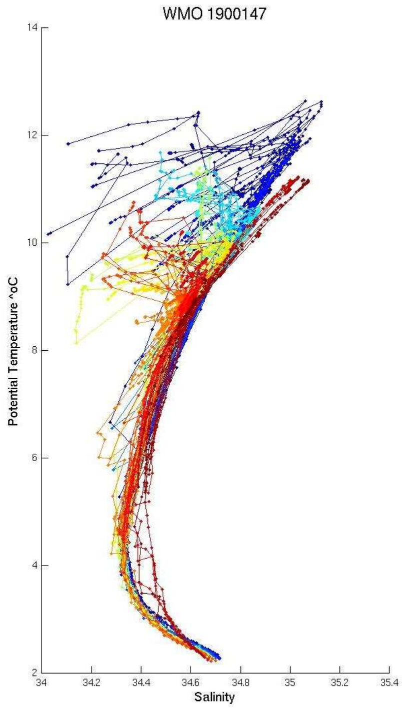


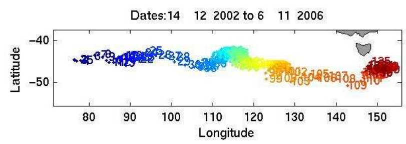
Conclusion. This is an example of float requiring only marginal adjustments. The majority of DACs applied no adjustments whilst attaching a larger estimate error to the measurements. However, MEDS applied a linearly proportional salty adjustment difficult to comprehend.

WMO 1900147

AOML APEX_SBE Stephen Riser

Park 1000db, profile 1000db, profile 2000db every 4th cycle

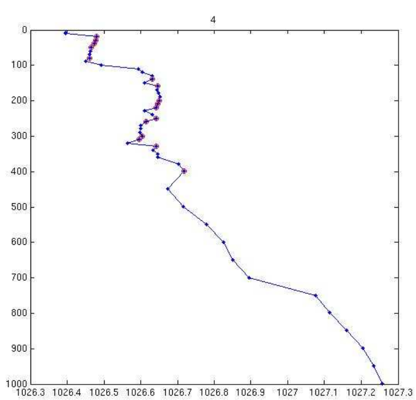




Long-lived APEX in the sub-antarctic zone which drifted south of Australia.

Deep T/S looks reasonable and in good agreement with other floats.

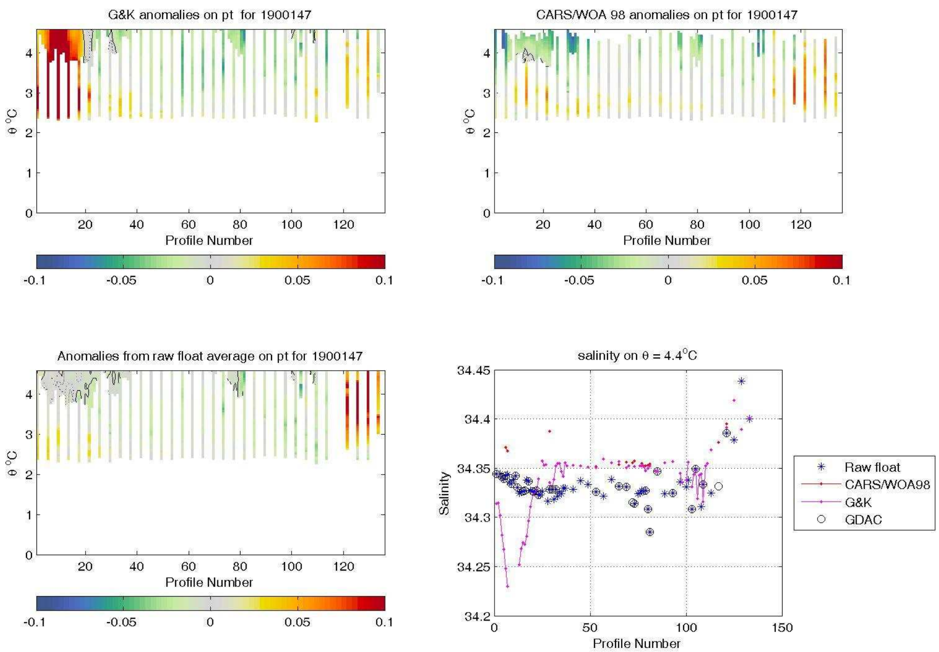
QC Flagging:
Profile 4 is noisy and has many inversions above 10°C.



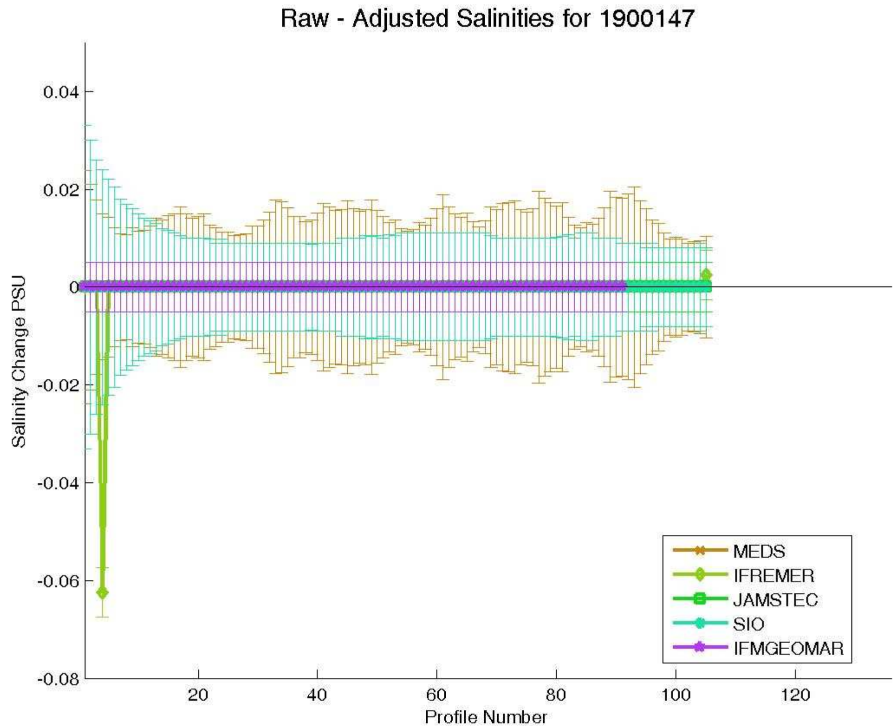
Large inversions were also found in profile 32 at 300m and profile124 near 200m in the mixed layer. Many profiles had R/T QC flags set to 2 where the data was good.

Again, only a few DACs recovered this data to 1 – several just passed along the R/T flags unedited.

Salinity Drift:
Deep salinities appear quite stable during the float lifetime and close to climatology near the bottom of the profles.



All DACs agree on no statistically significant adjustments and error bars are similar.

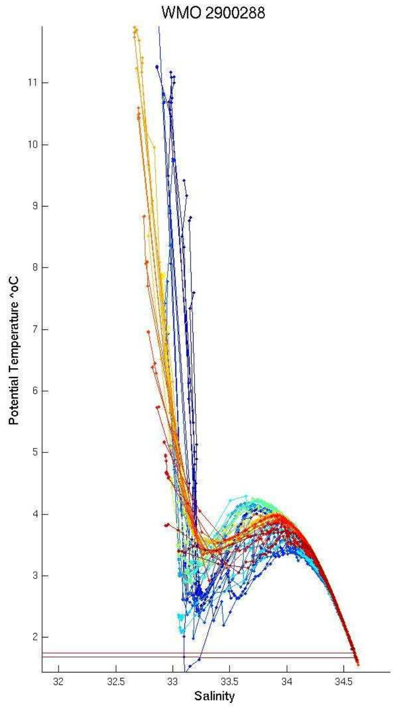


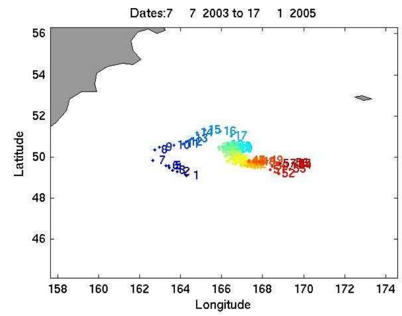
Conclusion. In this float, many data-points were assigned incorrect QC flags by the real-time QC tests. This indicated that the real-time QC flags should not be automatically trusted and showed the importance during the DMQC process of scrutinising all QC flags.

WMO 2900288

JMA APEX_SBE JAMSTEC

Park 2000, profile 2000



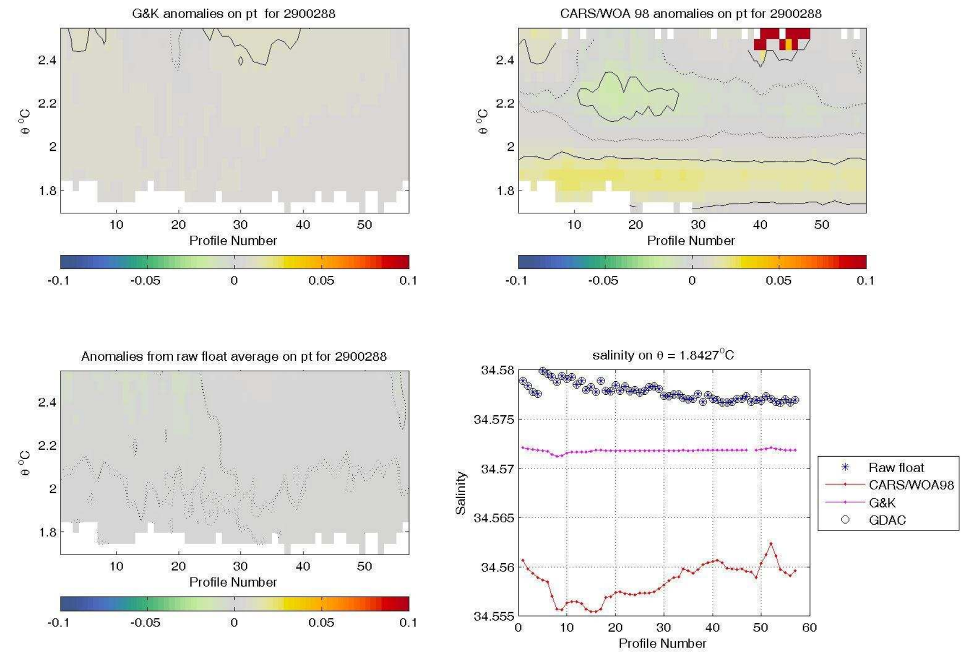


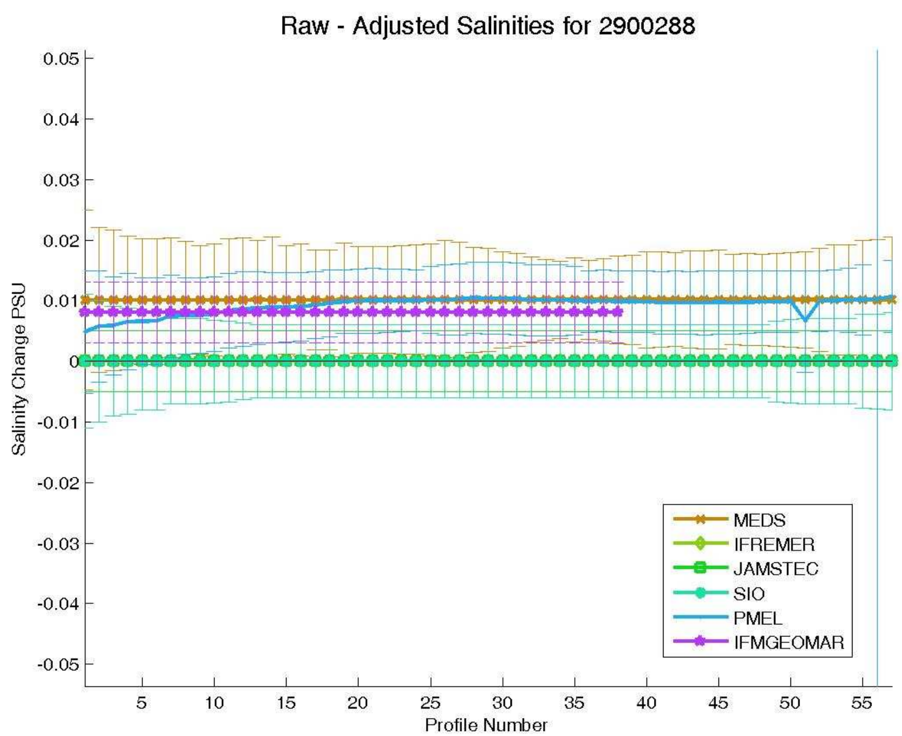
Subarctic NW Pacific

QC Flagging:
This float has deep salinity hooks –which need to be flagged QC= 3 or 4.
Profile 51 contains a thermal lag spike has RT QC= 4
Profile 56 – RT QC caught a fresh spike(4) but TEMP was also set to 4 which had to be changed back to QC=1.

No DAC flagged the deep salt hooks (except CSIRO) – nearly all DACs accepted the R/T flags and passed these to adjusted fields.

Salinity Drift:
This sensor is beautifully stable throughout its lifetime (see figure below). Interestingly, compared to the G&K climatology, there is no bias (< 0.005), while compared to WOA98, the float is 0.015 biased salty near 1.8°C. Several groups adjusted the float for a small nearly-constant +0.01 bias. Though the error bars do overlap, the adjusted values lie outside the error bars for the unadjusted sets.

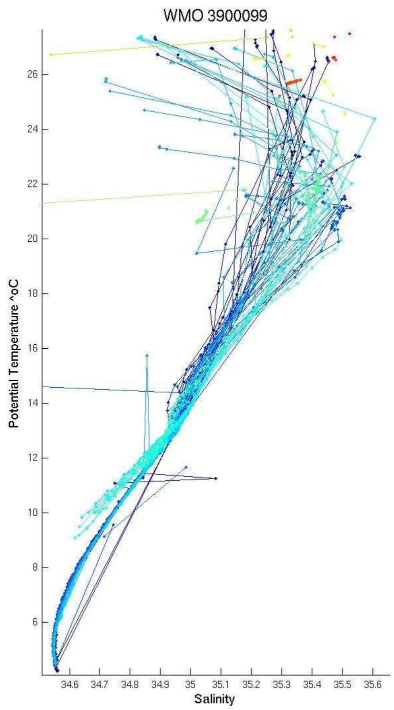

G&K anomalies on pt for 2900288
CARS/WOA 98 anomalies on pt for 2900288
Anomalies from raw float average on pt for 2900288
salinity on θ = 1.8427°C
θ °C
Profile Number
Salinity
Raw float
CARS/WOA98
G&K
GDAC

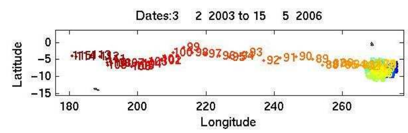

Raw - Adjusted Salinities for 2900288
Salinity Change PSU
Profile Number
MEDS
IFREMER
JAMSTEC
SIO
PMEL
IFMGEOMAR

WMO 3900099

AOML APEX_SBE Stephen Riser

Park 1000, profile 1000





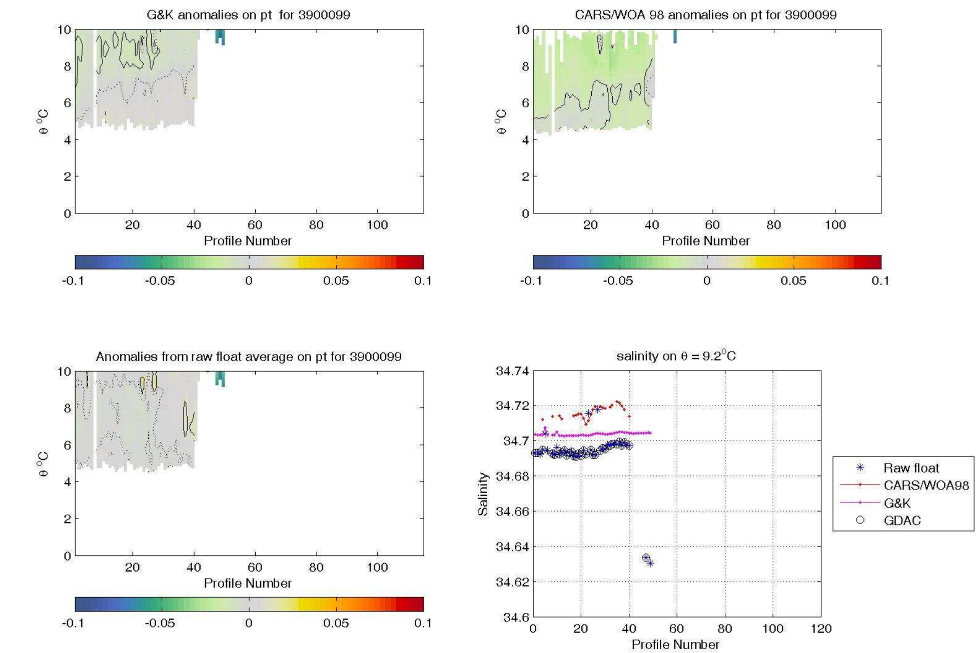
Deployed in the eastern Tropical South Pacific, this float traversed most of the Pacific at 5°S from east to the dateline - the float became essentially a surface drifter after profile 60 due to a malfunctioning Druck-pressure sensor.

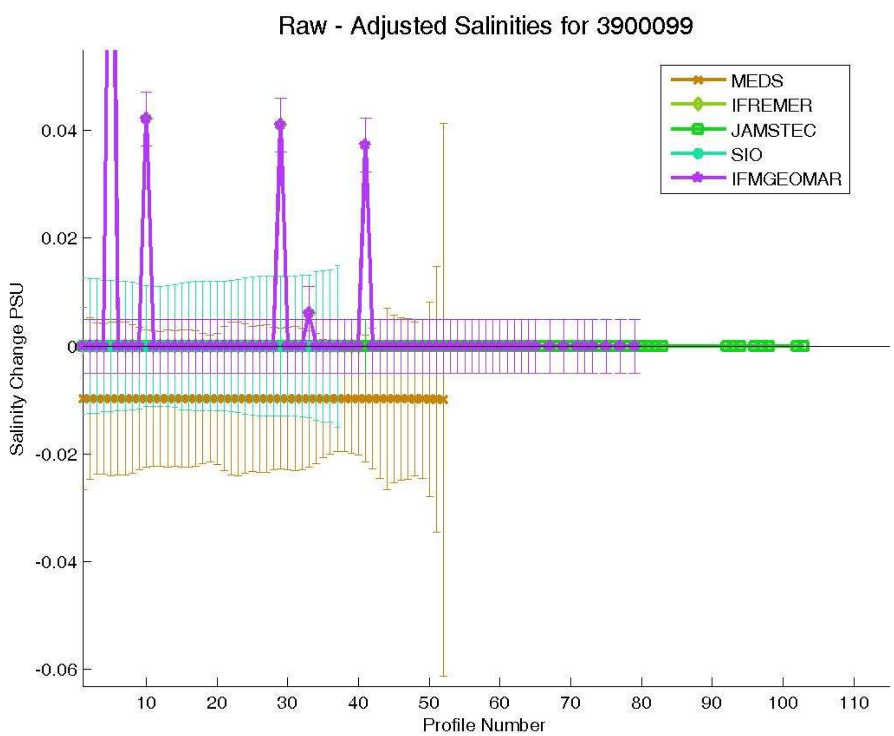
QC Flagging:

Due to the Druck data errors, this was very time-consuming – the R/T flags needed close inspection and editing. Many DACs set QC = 4 after profile 40 or so.

Salinity Drift:

Sensor drift could only be assessed where this float was still profiling to depth. The deepest measured salinities agree with climatology very well, suggesting no adjustment is necessary, which nearly all DAC's recommended, except MEDs where a 0.01 fresh bias was diagnosed. However, MEDs error bars include the no-bias scenario.

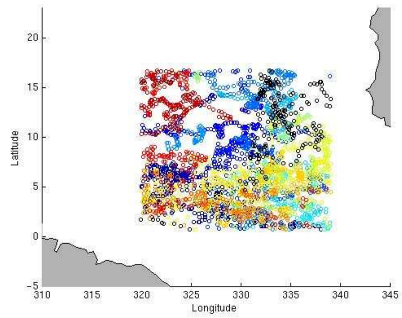

G&K anomalies on pt for 3900099
CARS/WOA 98 anomalies on pt for 3900099
Anomalies from raw float average on pt for 3900099
salinity on θ = 9.2°C
θ °C
Profile Number
Salinity
Raw float
CARS/WOA98
G&K
GDAC

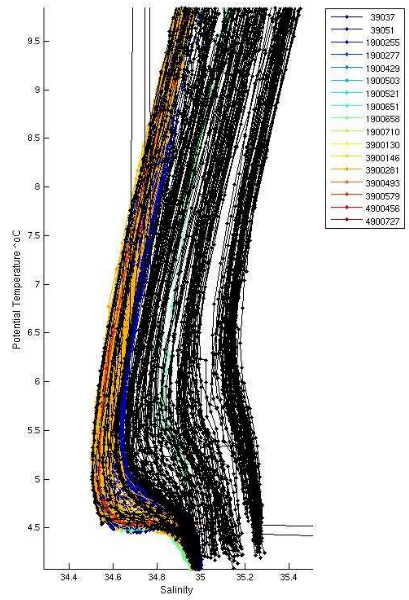

Raw - Adjusted Salinities for 3900099
MEDS
IFREMER
JAMSTEC
SIO
IFMGEOMAR
Salinity Change PSU
Profile Number

WMO 3900132
Coriolis APEX_1.1

Park 200, profile 1500

Tropical Atlantic deployment with strong deep salinity drifts.





QC Flagging:
Overall this float featured lots of gappy and spikey profiles – there are many temperature spikes and no associated salinity spikes – how to explain this? Depth table sampling appears steady but with some gaps.

NOTE: this float has real-time data in the GDAC that is very noisy compared to the version Tseviet distributed which seems much cleaner.

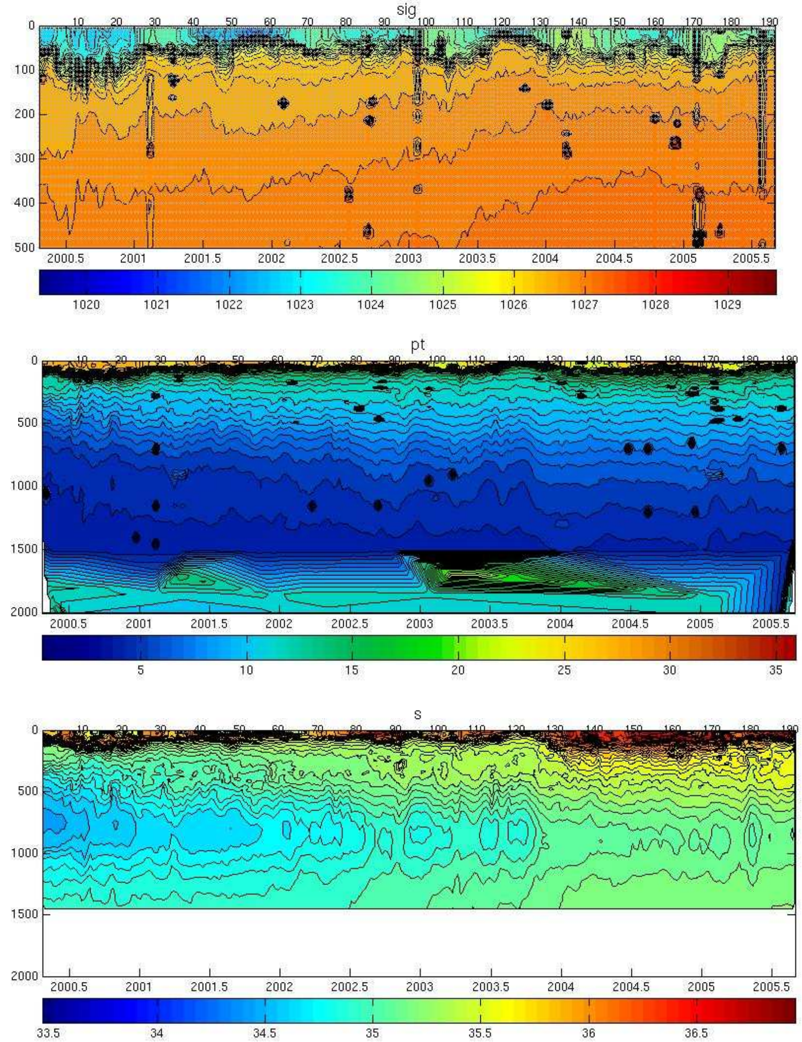


Figure above shows the temperatue, density and salinity of data from WMO 39000132 taken from the GDAC in September 2006, where the raw fields have many strange temperature spikes – while salinity is smoother. The R/T fields on the GDAC differed from those distributed by CSIRO for the intercomparison, which had been downloaded from the GDACs earlier.

DETAILED QC NOTES: -

Profile 108 has a mid-depth inversion – looks like a warm T spike with high salinity spike, but salinity spike washed out by thermal lag? No qc changes made

Profile 110,111 – large inversion in the mixed-layer due to salinity going salty near surface – set QC = 3

Profile 122 – whole S profile set to RT QC = 3 - no obvious reason why? Set back to QC = 1

Profile 129 – crazy profile – RT = 4 was found and is right!

Profiles 141,142,143,144 – as above, but also deep salts set RT QC = 3 – seem ok, set back to 1

Profiles 148 and others – temperature decreases in the mixed-layer – air/radiation cooling?

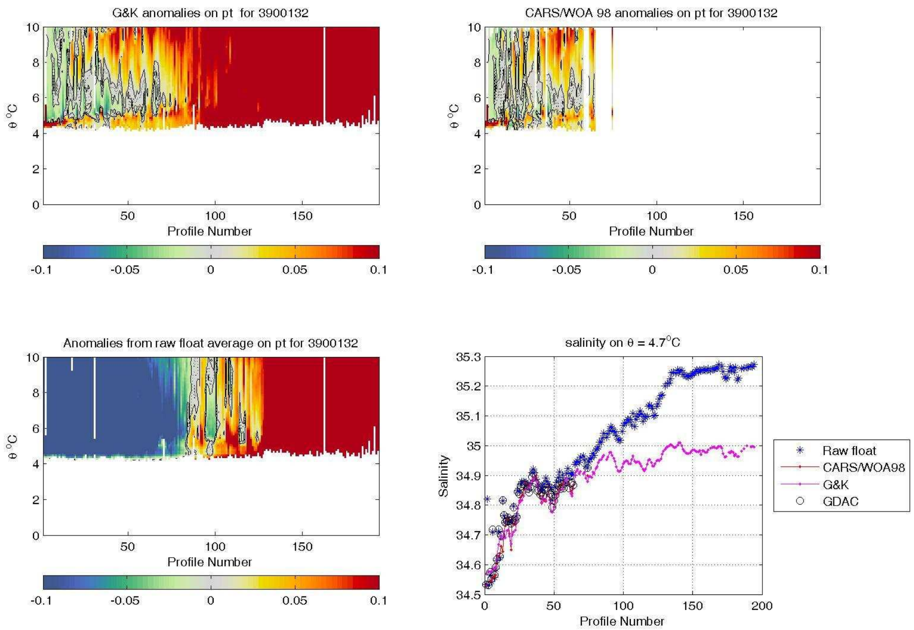
Profiles 172,176 – large S spike

Profiles 171 – temperature spiking, and not salinity spiking as in above profiles

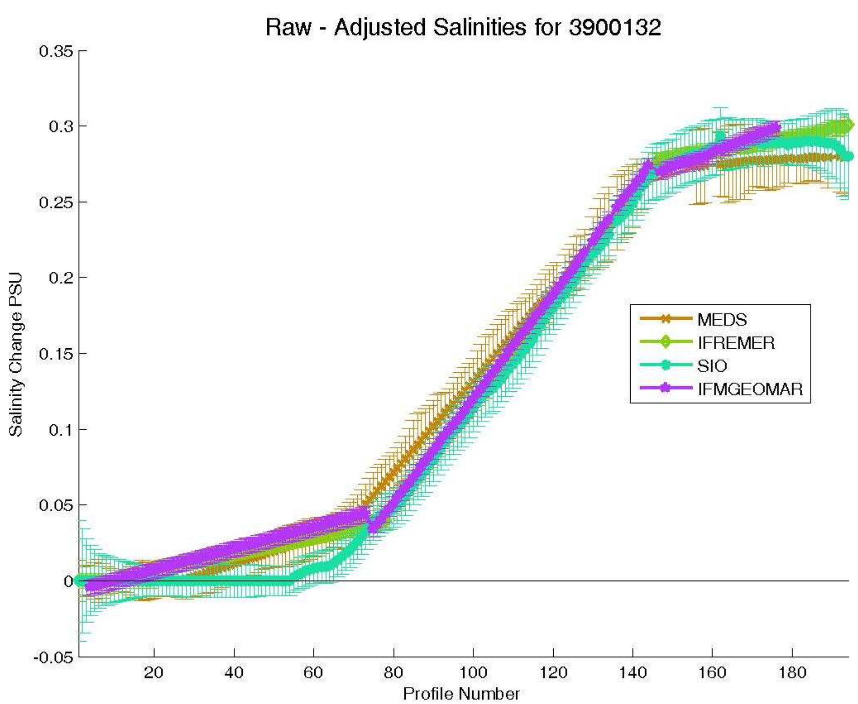
Profiles 180 – whole S profile set RT QC=3 – not sure why, set back

Summary – odd spikes and offsets. Several profiles where RT QC = 3 for all or most of S and not sure why! Set back to QC = 1

Salinity Drift:



This sensor undergoes a strong drift to higher salinities. For profiles 1-30, this change is caused by float spatial drift as reflected by good agreement with climatologies (see Figure above), but as the float ages, it clearly departs from climatology by as much as 0.25 psu.



All DACs that analysed this float removed the strong drift, and adjustments agree within the stated error bars in general, though some groups e.g. IFMGEOMAR and SIO report smaller error bars than other groups. Where drift adjustments disagree outside the errorbars is near the break point around profile 60-70 where the sensor starts drifting quickly to higher salinities.

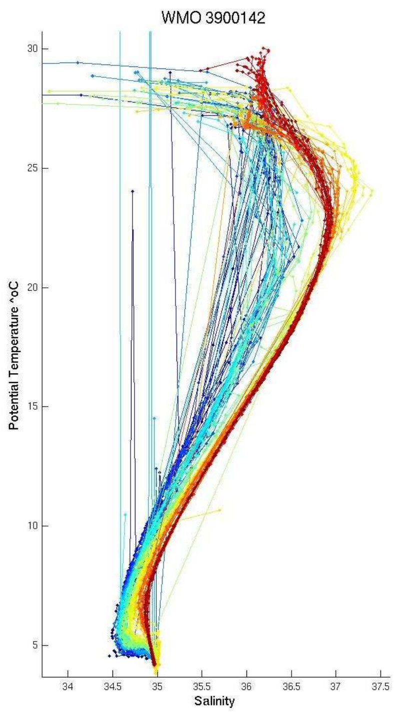
Conclusion. This float provides an example of the difficulty of adjusting the measurements near break points. The fine-scale interpolation approach used by SIO appears to produce adjustments that are more realistic than those produced by the straight mathematical approach adopted by MEDS and IFMGeomar.

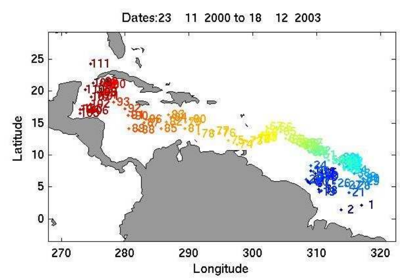
WMO 3900142

Coriolis APEX_1

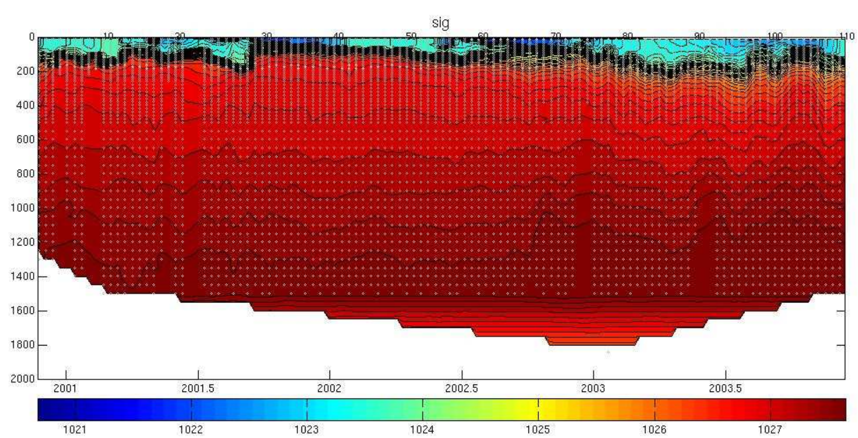
Park 200, profile 1500

This float drifts from off Brazil into the Caribbean, and thus samples a large range of deep water-masses.





I

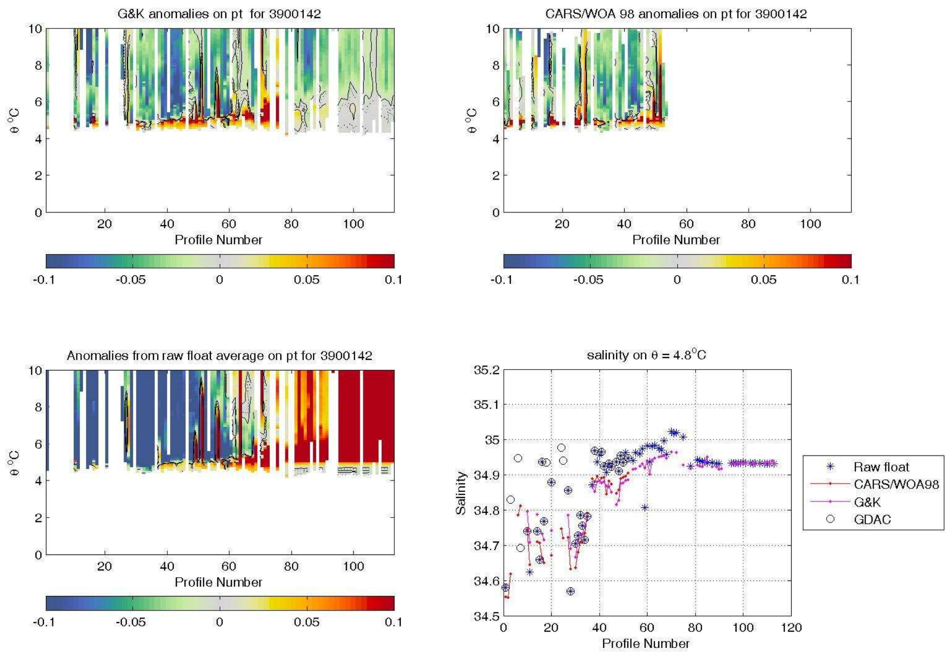


The float clearly ran aground several times (see the density contour plot above with sample locations indicated by white dots), and also stopped reporting for a few cycle after profile 50 (stuck on bottom?).

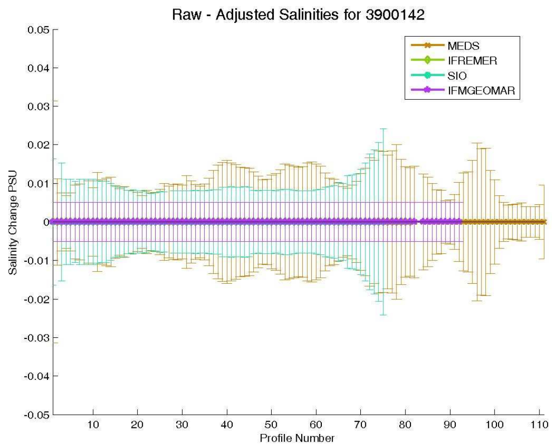
QC Flagging:
Profile 56 – spike in ML
Profile 80 – gaps and bad deep P

This is another float where the raw data on the GDAC differs from the earlier version of the R/T data and the GDAC data appear corrupted (need to investigate with Sylvie). Hence those that lifted the R/T data off the GDACs have very different QC flags from those that used the CSIRO distributed R/T data files.

Salinity Drift:



Above: Salinity anomalies for the GDAC version of the raw data for float 3900142. Large gaps and spikes are present in this data. The strong deep salinity shifts make identifying sensor changes difficult. However once in the Caribbean, deep values agreed well with climatology.

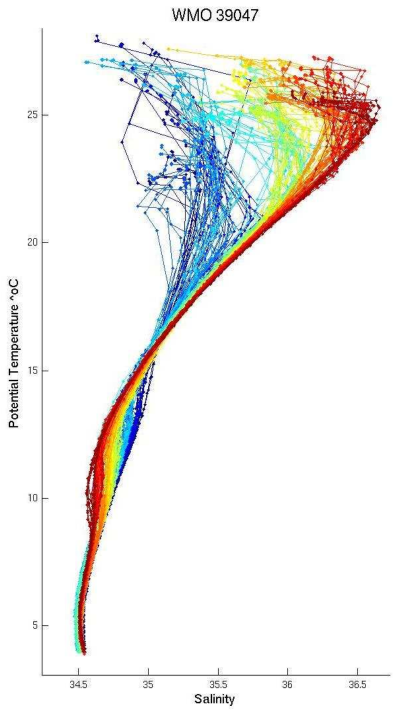


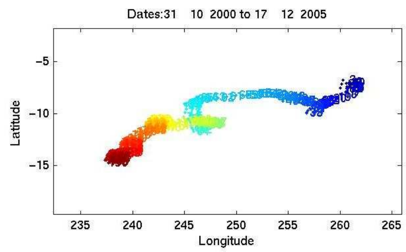
As can be seen above, all DACs assess zero drift for this sensor.

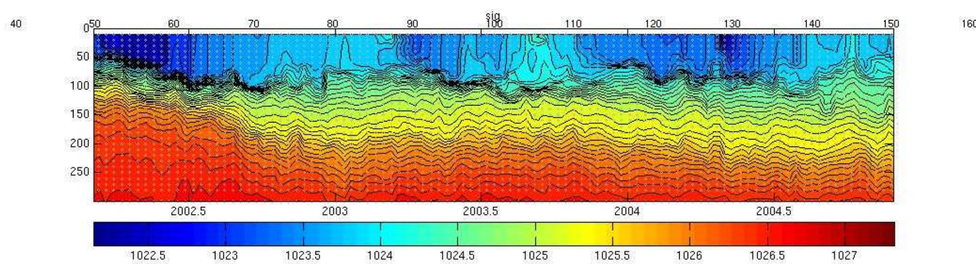
WMO 39047

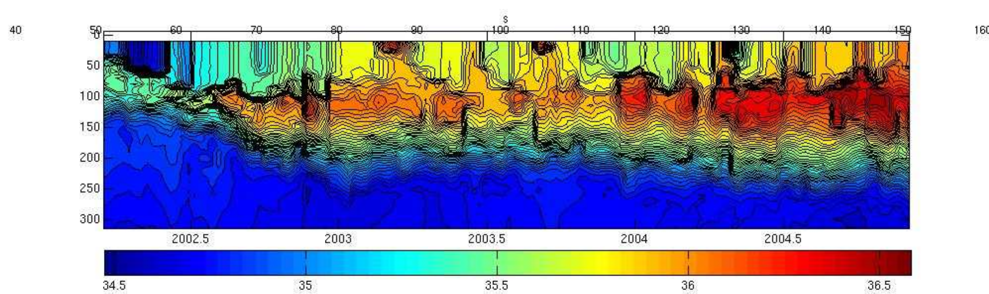
SOLO_SBE Dean Roemmich

Park 1000, Profile 1080





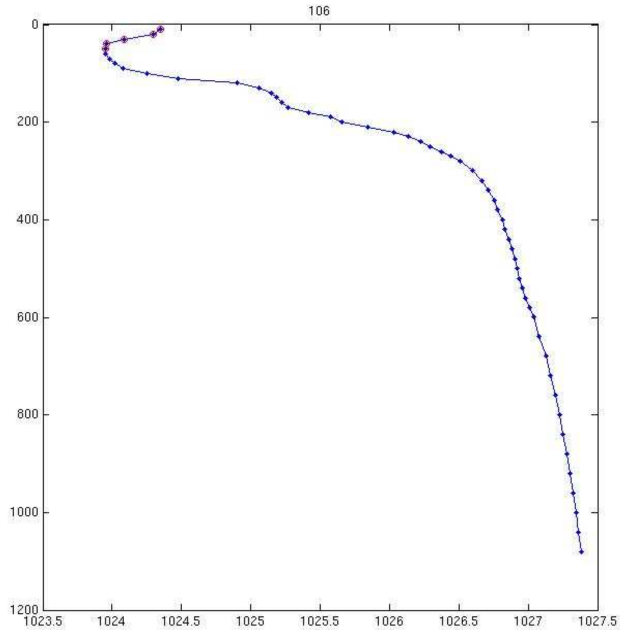




This is a long-lived SOLO profiling only to 1000db in the low-latitude South Pacific.

QC Flagging:

We noted significant near surface inversions – high salinity surface layers over fresher waters. Nearby Argo floats did not show similar salty shallow bullets of water causing inversions. See the example for profile 106 below.

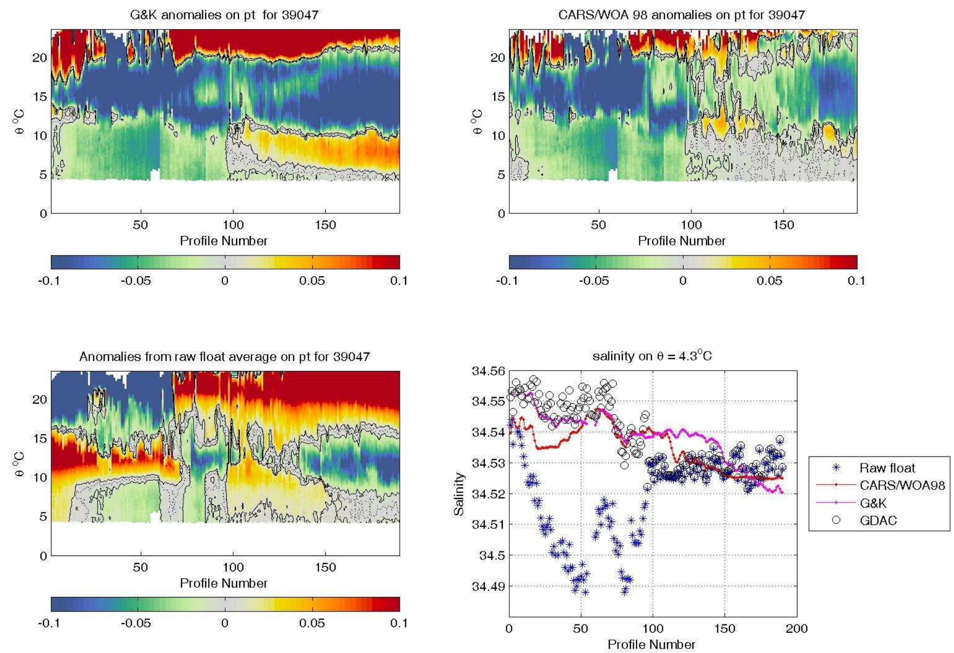


These features may show a sensor malfunction, but we don't have physical explanation, unless the float drifted in the mixed layer for a long time and we are seeing lateral fine-scale aliased into the profile.

The QC flags applied to these inversions varied between groups. The original R/T flags put QC=2 on the gradient regions below these inversions. All the unstable values are QC=4 on the GDAC (SIO), CSIRO set QC=3 and JAMSTEC flagged the gradient region bad, but left the near surface values QC = 1. IFREMER set QC =2 everywhere on this float, except where the RT flags had been tripped.

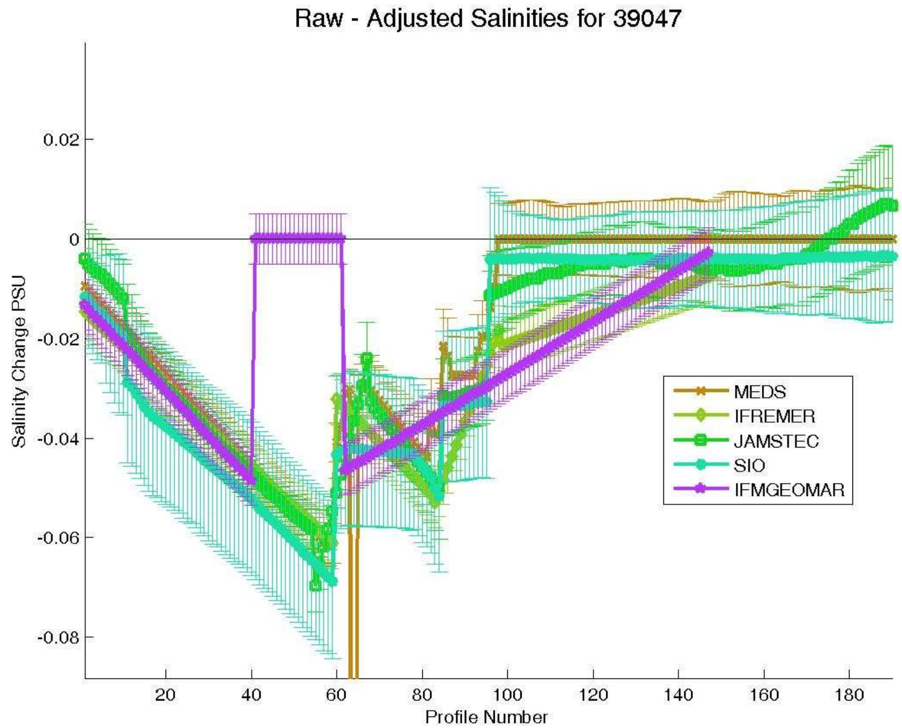
This float also has an example where the R/T flags had QC=2 on profiles 55, 56,57,58, 59 from 800m to the bottom of the profile with no obvious reason. In delayed-mode these needed to be changed back to QC=1. Only SIO, IFM GEOMAR recovered this data.

Salinity Drift:
Raw salinities in this float show a striking fresh deviation compared to climatologies where values initially start close to mean conditions at depth, and then drift sharply fresh for about 1.5 years, and then return to climatological values towards the end of the float life.



This variability presents a puzzle as to what is happening to the sensor – rarely do they return to calibration after drifting. Is this indicative of a biological resident that left? The fact that the differences from climatology are rather uniform for temperatures below 12°C on a given profile strongly indicate this is a sensor problem and is not natural variability. Comparisons with nearby Argo data also show that this float falls outside of variability at the very coldest temperatures within a wide surrounding region (±5° latitude and longitude).

Adjustments were made by all DACs (see figure below) and apart from those made by IFMGEOMAR, their error bars overlap indicating formal agreement despite the > 0.05 psu change. The float drift required multiple piece-wise groupings and it is arguable whether the large-window smooth approach can model this sensor drift – e.g. see JAMSTEC correction using WOD01 (below) which was not able to model the changes in float bias.



Interestingly, Professor Matthais Tomczak has also included this float in a study of variability of the Antarctic Intermediate Water layer in the South Pacific, and he contends the variability measured by 39047 is real. His arguments are laid out below.

Appendix to a paper in preparation by Matthais Tomczak: the data quality of float 39047

Float 39047 spent its life in the tropical eastern Pacific Ocean, moving slowly westward from 7°S 100°W to 14°S 123°W, covering the distance of more than 1400 nm in just under 5 years. After an initial period of three months, when its TS-data followed the WOA climatology closely, its TS-data departed significantly from the WOA climatology for 2.5 years before returning to climatology during the second half of its history (from September 2003; Figure 9). The Argo team assessed its data quality as affected by sensor fouling and based this assessment on a comparison of its TS-data with climatology and neighbouring floats, not only at the AAIW level but across the permanent thermocline as well (Wijffels, personal communication).

TS-relationships of thermocline water masses are well defined and very tight, so comparison of data on the basis of thermocline TS-relationships is usually a good tool for quality control. The thermocline of the Pacific Ocean contains several varieties of Central and Equatorial Water, each confined to its own region and separated by neighbouring varieties by well defined fronts, which complicates their use as a quality control tool. Two extensive “transition zones” between Central and Equatorial Water and subpolar water masses are found along the eastern periphery (Figure A1).

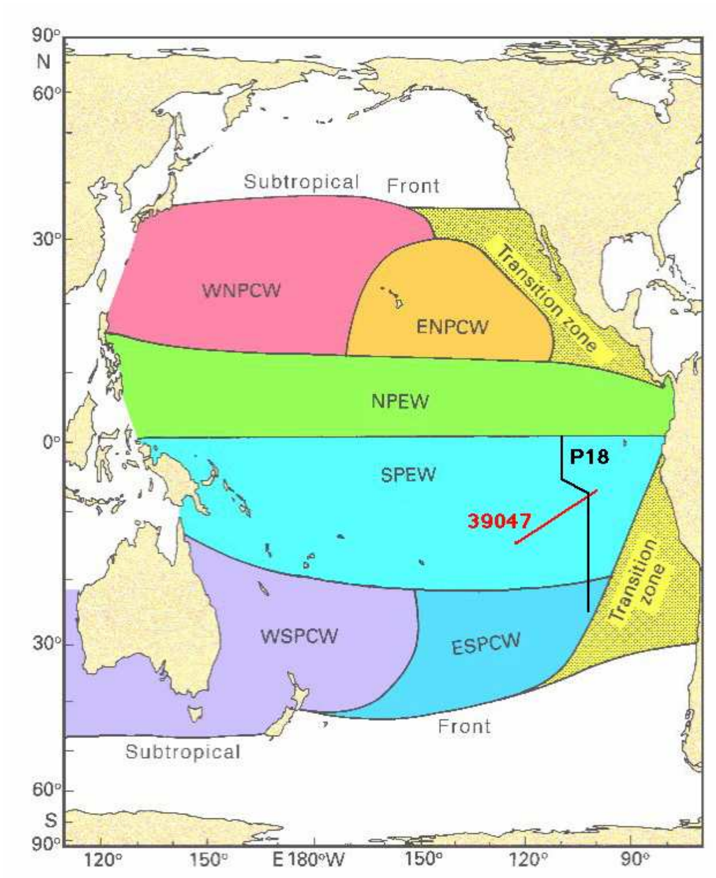


Figure A1: The water masses of the thermocline of the Pacific Ocean. PCW: Pacific Central Water, PEW: Pacific Equatorial Water, S: South, N: North, W: Western, E; Eastern. Adapted from Tomczak and Godfrey (2003). The red line indicates the approximate track of float 39047, the black line WOCE section P18.

The eastern South Pacific is among the least explored regions of the world ocean, and the location of the water mass boundaries is not well established. Based on the schematic sketch offered by Tomczak and Godfrey (2003) WOCE section P18 along 103°W should have been in South Pacific Equatorial Water to about 20°S and in East Pacific Central Water until about 30°S, where it should have entered the "Transition Zone" and begin to show lower salinities indicating subpolar influences. Inspection of data from the section indicates that when the section was performed in 1994 the transition region reached significantly further west; lower thermocline salinities were observed well before 30°S (Figure A2). When the TS-data of Argo float 39047 are compared with the WOCE section it is seen that the float data are inside the envelope of the WOCE P18 TS-data, suggesting that all data from the float represent oceanic properties from the region and should therefore be acceptable in principle.

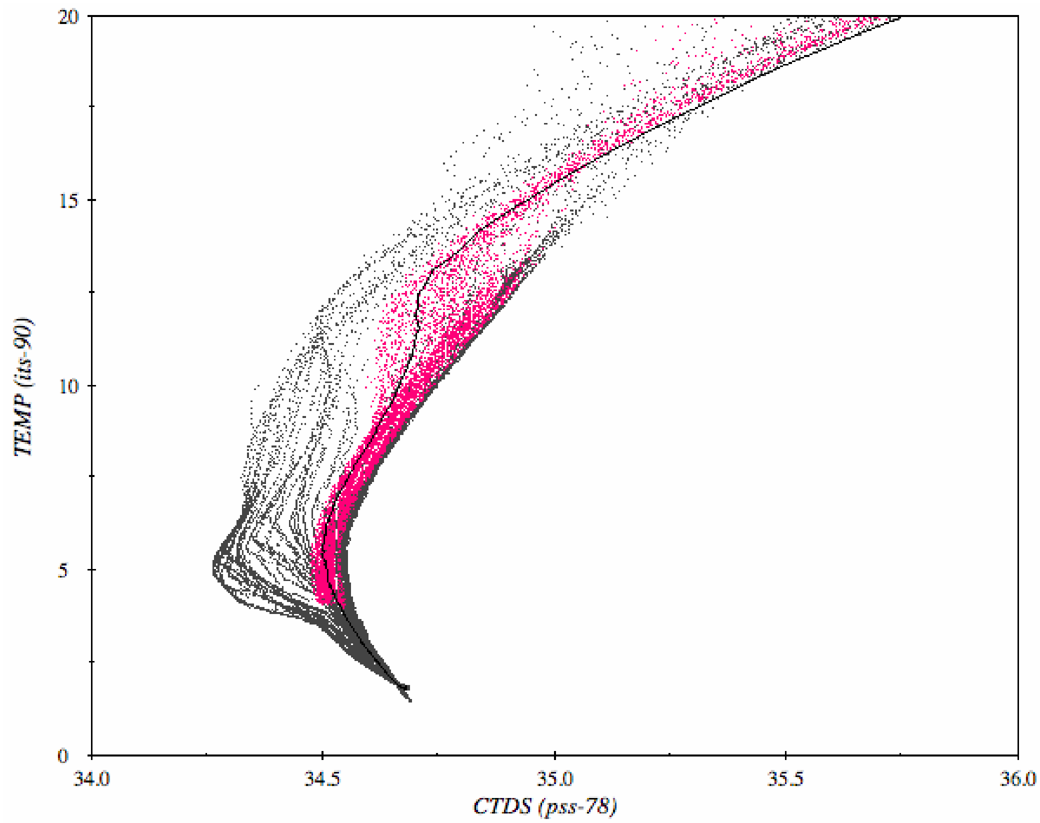


Figure A2: Cumulative TS-diagram for WOCE section P18 between the Equator and 30°S (black) and Argo float 39047 (red). The shift from high to low salinity at temperatures above 10°C indicates the transition from Equatorial and Central Water to subpolar water. The black line through the data is the TS-diagram of the WOCE P18 station at 15°S in the centre of the frontal zone between subtropical and subpolar water masses. The data show the presence of the Transition Region at the section in 1994.

Comparison with neighbouring floats is less conclusive. Several floats (3900062, 3900067, 3900118) are either corrupted from the start or show severe drift. Other floats (3900159, 3900108), which agree with the WOA climatology, were not deployed until mid-2003 when the TS-record of 39047 also began to return to climatology. Float 39053, which began recording in early 2001 some 350 nm north west of float 39047, returned only four values over a period of a few months that show much variability (if they can be trusted). Float 39032, which began recording in October 2000, returned only eight values over a period of months that match the WOA climatology well but fall into the early observation period of 39047, when its data also matched the climatology.

Float 3900066, the nearest float of comparable quality, was launched in late 2001 some 900 nm south east of 39047, well within the Transition Zone. It shows similarly large TS-variability, and its TS-data overlap with those of 39047.

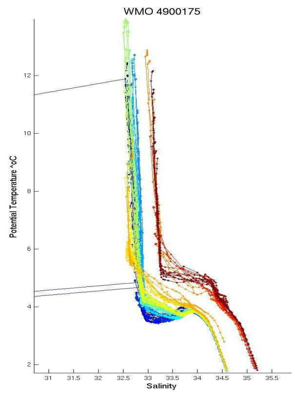
If the observations from float 39047 are accepted as correct they would indicate significant interannual variability in the location of the boundary between South Pacific Equatorial Water and the Transition Zone and suggest an extensive westward shift of the boundary during the first 2.7 years of observations from the float. The years 2002 and 2003 witnessed one of the strongest El Niño episodes in history, and it is tempting to speculate that the apparent widening of the Transition Zone off South America might be related to that episode.

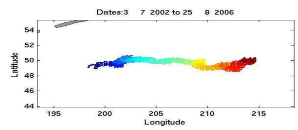
A relocation of water mass boundaries of hundreds of kilometers from the surface to more than 1000 m depth is a major event, and more evidence is required to verify that it occurred during 2002 – 2003. All available evidence suggests, however, that the data recorded by float 39047 during that period cannot be dismissed lightly and probably recorded a true event.

WMO 4900175

AOML APEX_SBE Greg Johnson

Park 1000, 1000 profile 2000, 1000 – why are there two entries?





Bering Sea float which undergoes a huge jump in deep salts ~ profile 102-103 ~ 0.5 saltier? Shape of T/S curve changes as well – this is likely pressure calibration problem – likely that all data is no good after profile 102?
Original calibration looks slightly saltier than nearby Argo.

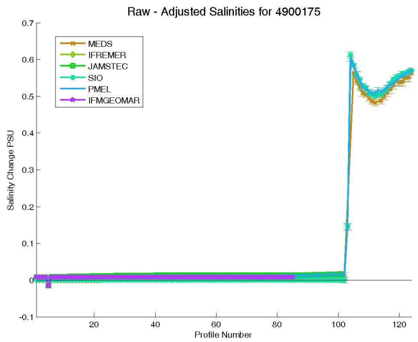
QC Flagging:

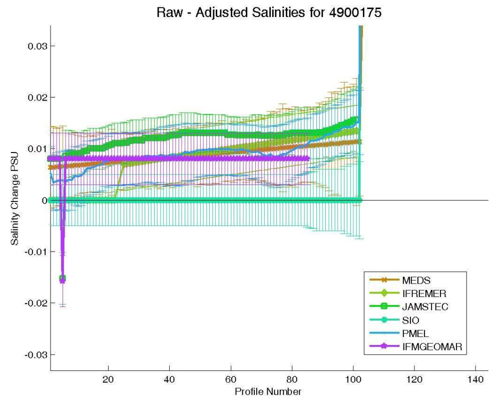
Inversions and spikes:
Profile 5 – spikes found at 100m, 0m
Lots of thermal lag inversions found at the base of mixed layer – these should be left for correction by thermal-lag software
Otherwise this is a very clean data set.

Most DACs recognized the serious error in data after profile 102 and flagged these data bad, though some attempted to correct for the large drift.

Salinity Drift:

Most DACs deduced a high salinity bias in this float before profile 102, and corrected these profiles, though one DAC asserts no correction was needed. Several DACs provided adjusted data for profiles after 102 – when it is not clear that these data are adjustable.

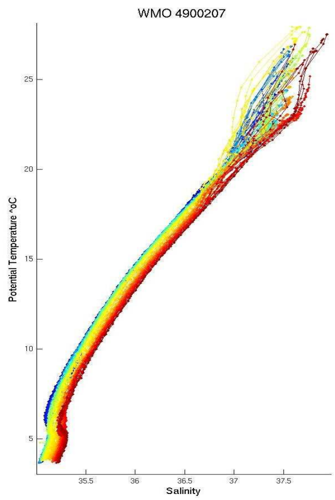

Raw - Adjusted Salinities for 4900175
MEDS
IFREMER
JAMSTEC
SIO
PMEL
IFMGEOMAR
Salinity Change PSU
Profile Number

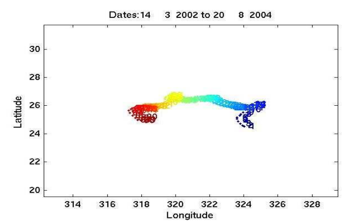

Raw - Adjusted Salinities for 4900175
MEDS
IFREMER
JAMSTEC
SIO
PMEL
IFMGEOMAR
Salinity Change PSU
Profile Number

WMO 4900207

Coriolis PROVOR sensor not noted in file Yves Desaubie

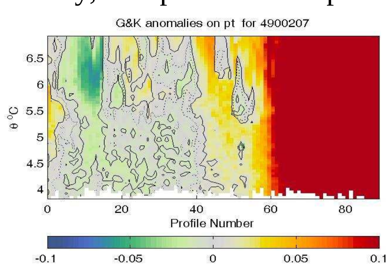
Park 1500, 2000 profile

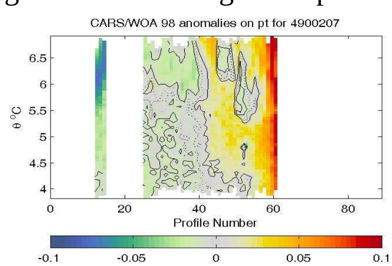


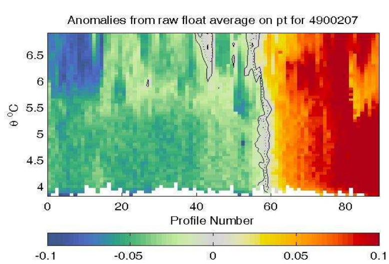


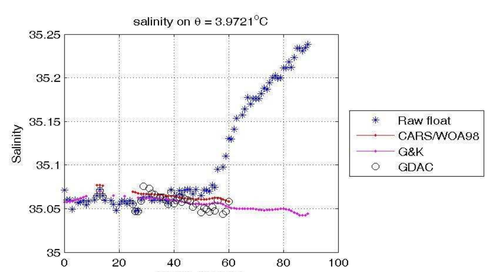
A float operating in the subtropical N. Atlantic with a strong salinity drift to high values which is confirmed by comparison with nearby Argo

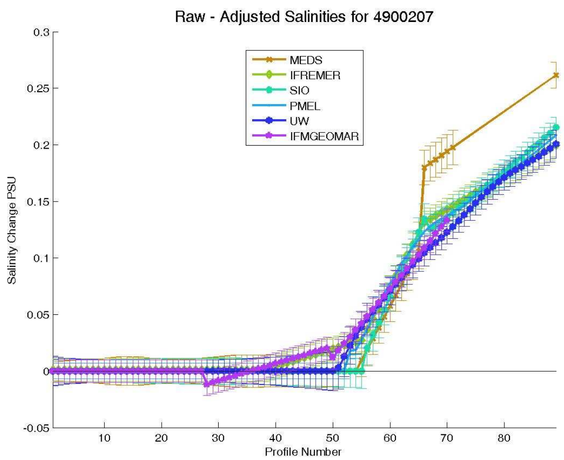
QC Flagging:
Profile 5 – salt spike near 1600db set QC to 4.
Profile 87 – all salts set to RT QC = 3 – had to revert back to 1
Salinity Drift:
This float remains close to climatology at depth until about profile 55, where a strong drift to high salinities starts. All DACs diagnosed the drift and corrections agree fairly closely, except near break-points. Again error bars might be optimistic.









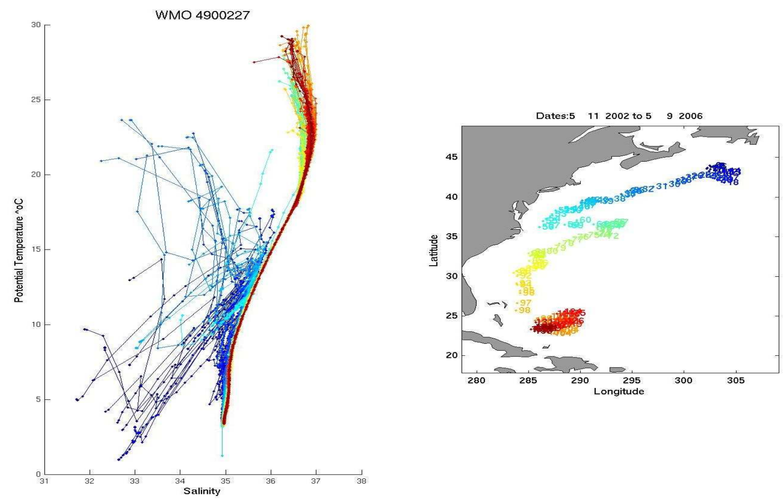


Raw - Adjusted Salinities for 4900207
MEDS
IFREMER
SIO
PMEL
UW
IFMGEOMAR
Salinity Change PSU
Profile Number
0.3
0.25
0.2
0.15
0.1
0.05
0
-0.05
10
20
30
40
50
60
70
80

WMO 4900227

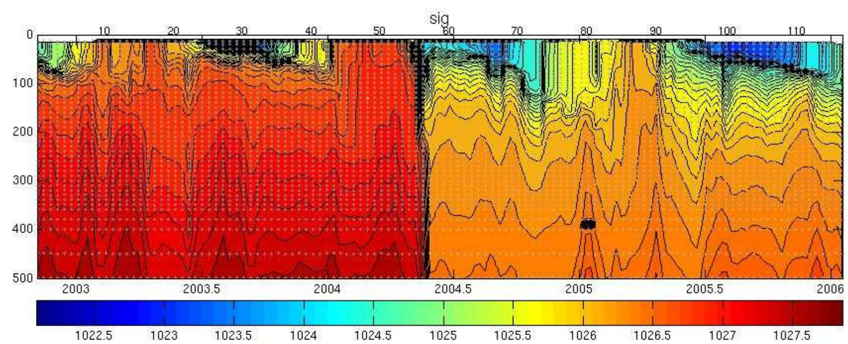
MEDS APEX sensor not noted in file - Howard Freeland

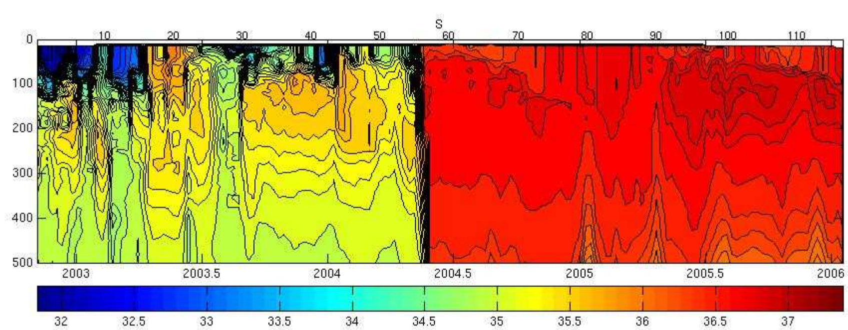
Park 2000, 2000 profile



Long-lived APEX which rides the Gulf Stream from25°N to 45°N

There is a possible drift to salty but strong water mass changes make this difficult to tell.



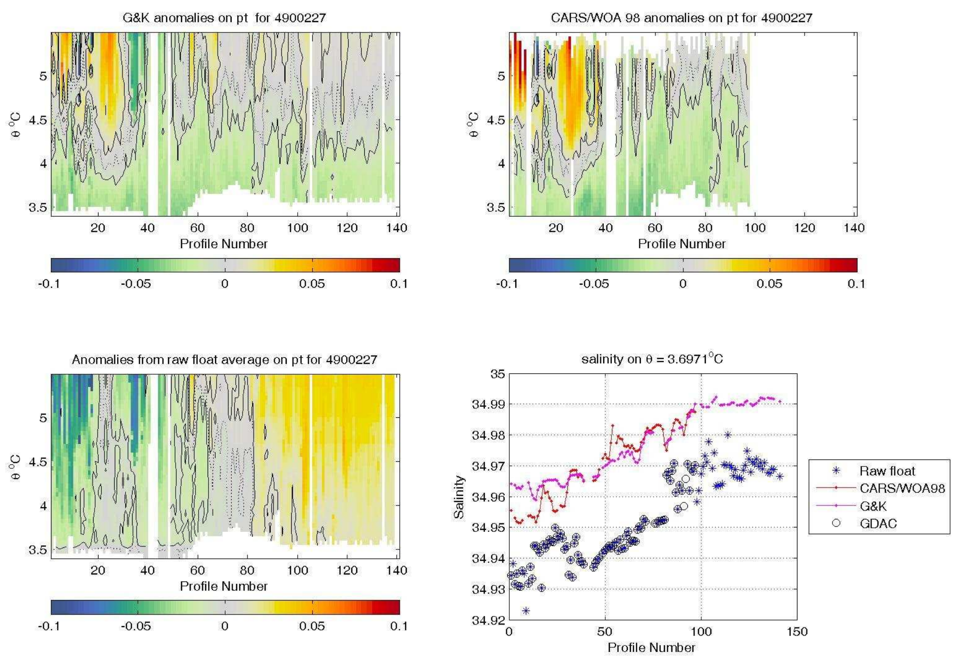


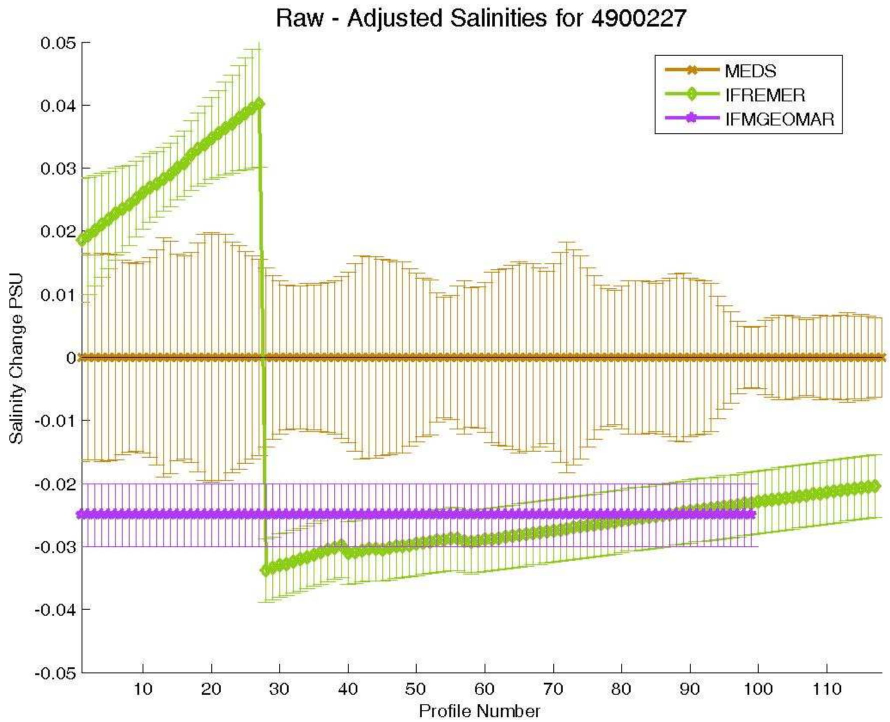
The float crossed the Gulf Stream near profile 56.

QC Flagging:

Profile 22 – large deep spike
Profile 23 – many inversions above 600m? Set QC = 3 on S above 9C
Profile 48 – deep spike
Profile 81 – deep spike
Deep spikes (some in T) picked up by RT

Salinity Drift:
Against climatologies, the drift to higher deep salinities is due to the real ocean changes. However, compared to WOA98 and G&K99, this float might have a constant deep low salinity bias of about 0.03 psu starting from profile 25 onwards. This is evident in IFREMER's adjustments, while MEDs (home DAC) choses not to adjust this float.



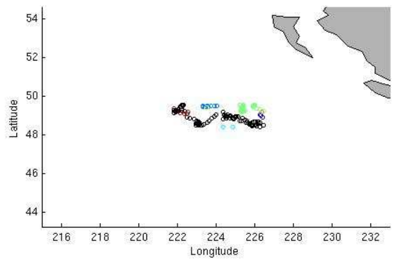

Raw - Adjusted Salinities for 4900227
MEDS
IFREMER
IFMGEOMAR
Salinity Change PSU
Profile Number
0.05
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
10
20
30
40
50
60
70
80
90
100
110

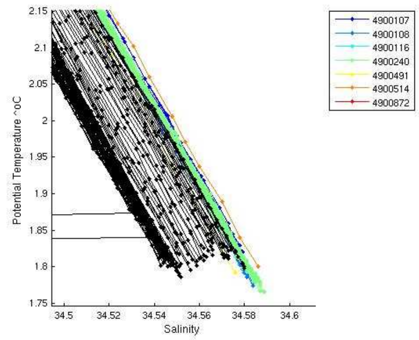
WMO 4900239

meds APEX [sensor not noted in .nc file] Howard Freeland

Park 2000, 2000 profile

NE Pacific location - very little spatial drift!





When compared to nearby Argo (see plot above), an evolving fresh bias is very clear!

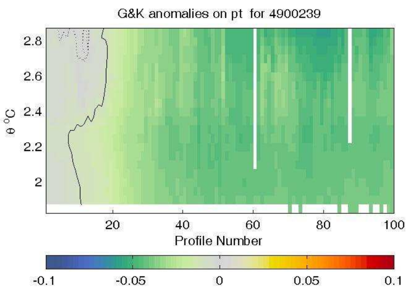
QC Flagging:
Profiles 4, 40 and 80 have silly surface values of T and S.
Profile 4 – surface and 900m spike
Profile 54 – ML spike
Profile 60 - 1700 spike
Profile 73 – 1000m spike and 1900m spike
Profile 89 – 700m spike

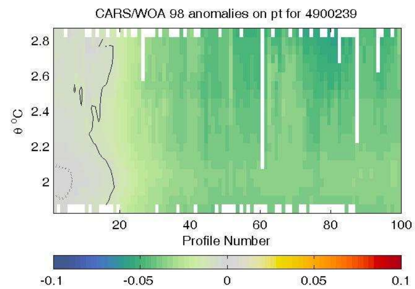
This float appears to have some deep salty hooks – which were not picked up my many DACs in DMQC.

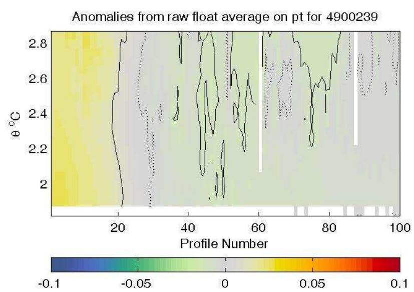
Salinity Drift:

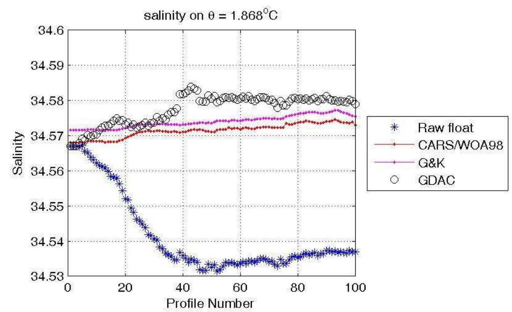
This float has a low salinity bias that grows from near zero to ~0.03 by profile 55 and then remains somewhat constant after that. The small spatial drift, very deep stable T/S in the region and the fact that the float samples to 2000db on every profile means that correction should be strait forward.

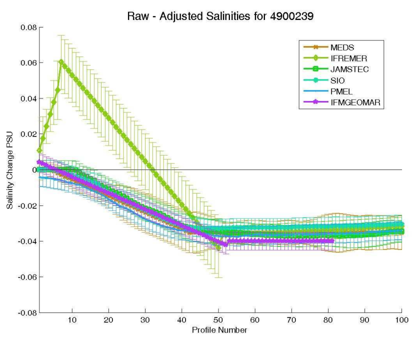
All DACs identified the bias and agreement between adjustments is good and within error bars, except for IFREMER which deduced a high salinity bias. Examination of the salinity anomalies for the full water column suggest that IFREMER’s corrections were dominated by real ocean variability above 800m.

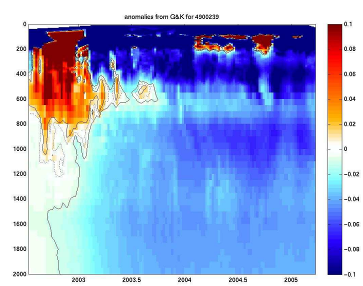

G&K anomalies on pt for 4900239
θ °C
Profile Number


CARS/WOA 98 anomalies on pt for 4900239
θ °C
Profile Number


Anomalies from raw float average on pt for 4900239
θ °C
Profile Number


salinity on θ = 1.868°C
Salinity
Profile Number
Raw float
CARS/WOA98
G&K
GDAC

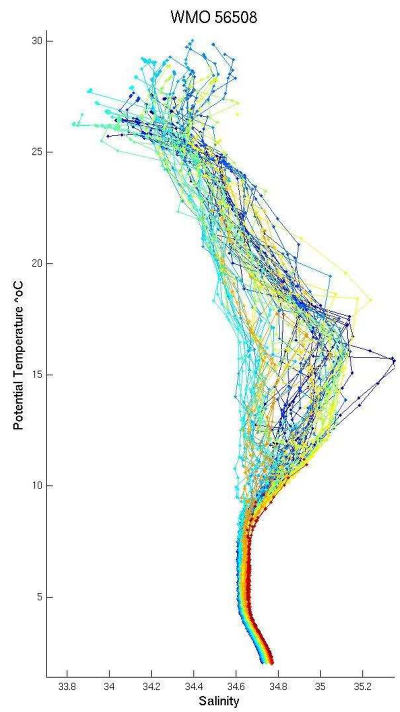

Raw - Adjusted Salinities for 4900239
Salinity Change PSU
Profile Number
MEDS
IFREMER
JAMSTEC
SIO
PMEL
IFMGEOMAR

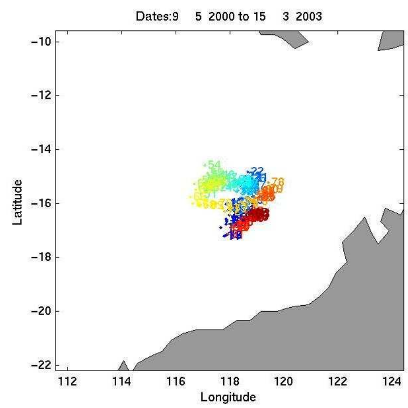

anomalies from G&K for 4900239

WMO 56508

CSIRO R1 PALACE_SBE Susan Wijffels

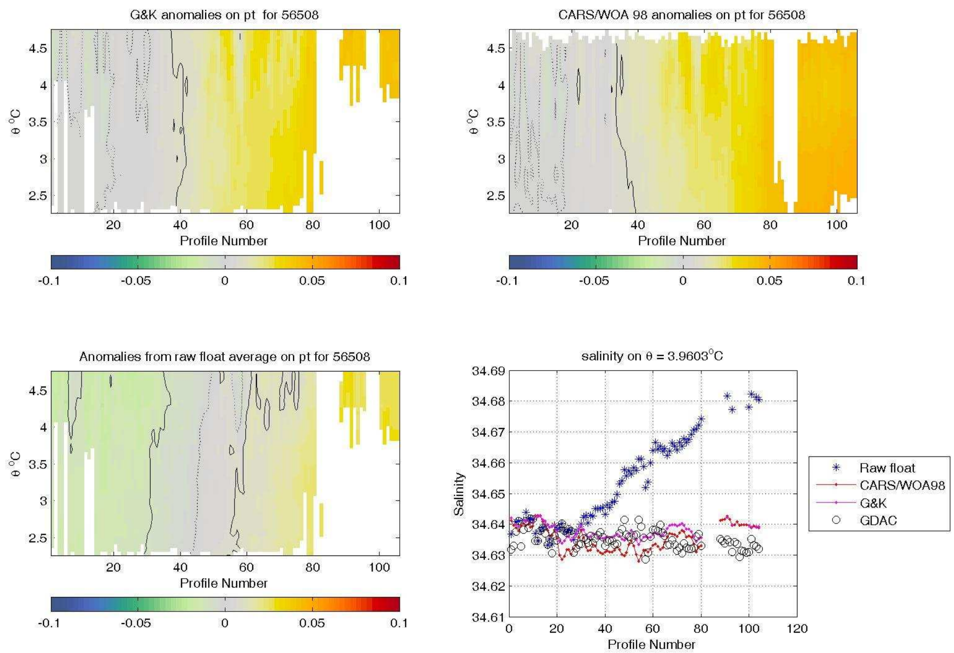
Park 2000, profile 2000



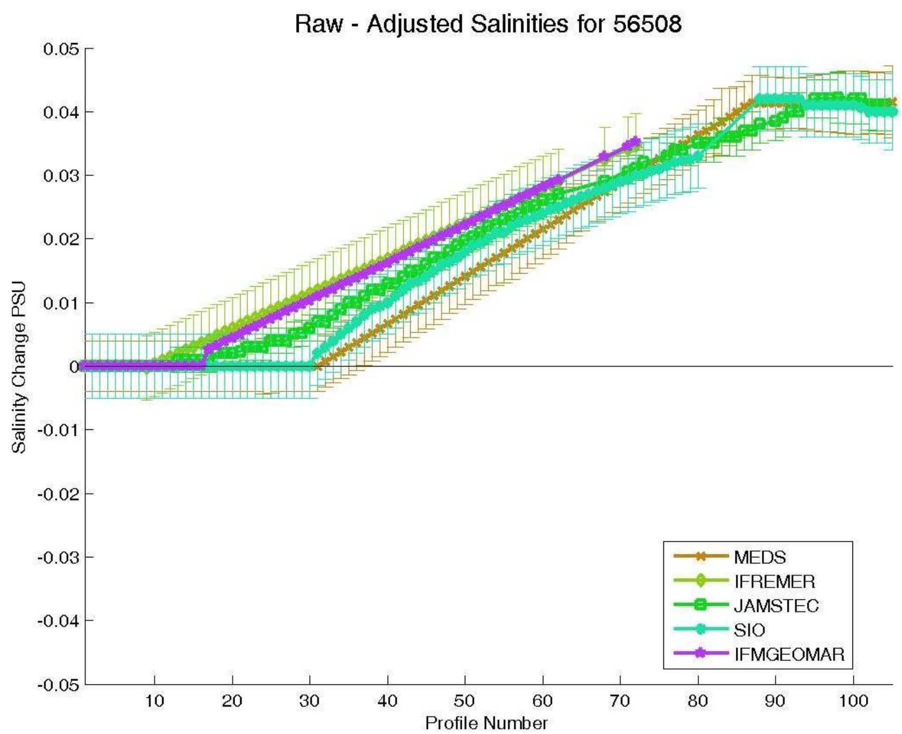


QC Flagging:
Strange deep data with T and S constant for last two points – salty hook similar to those diagnosed in APEX. Set QC = 4 for T and S – on these points on profiles 88,89,91-106. Many top-of-profile inversions present due to the stall of the float caused by dropping battery voltage affecting the floats' buoyancy engine. – QC = 4 for T/S when stalled (shallowest point).

Salinity Drift:



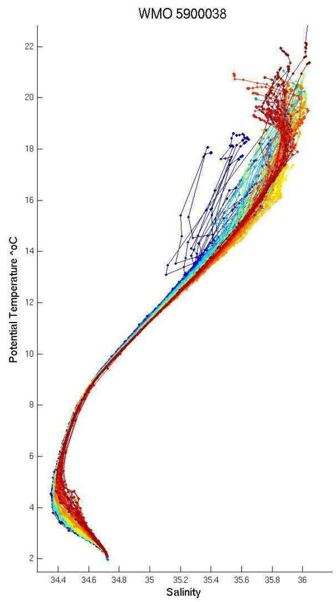
A slow drift to a high salinity bias is evident over the 1.5 years of operation. Again, DACs agree except near changes in slope and break points.

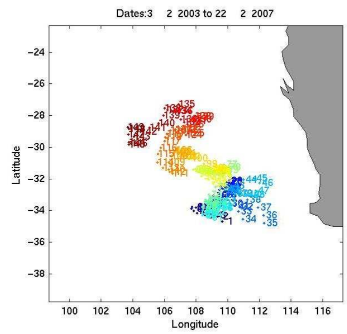


WMO 5900038

CSIRO APEX_SBE Susan Wijffels

Park 2000, profile 2000

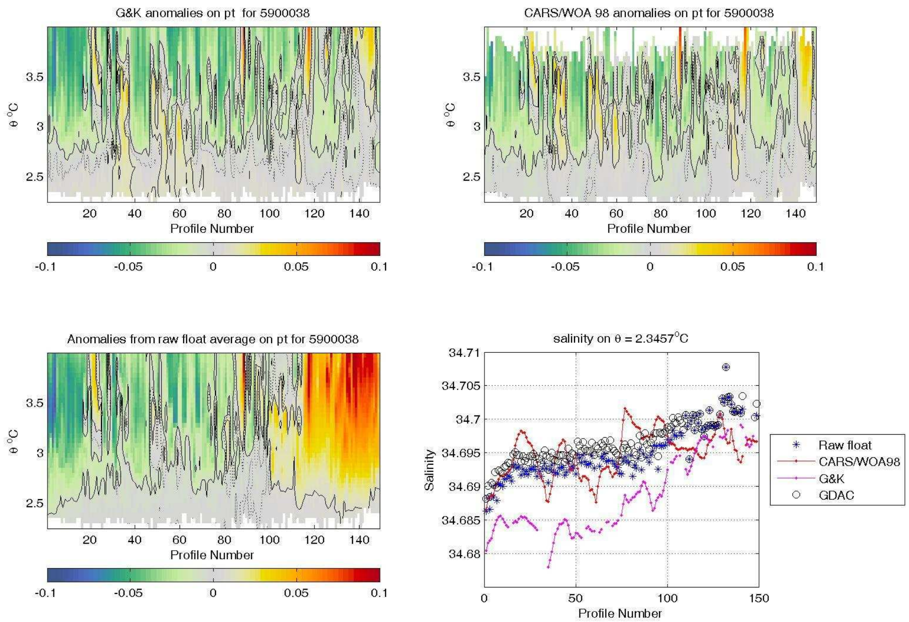


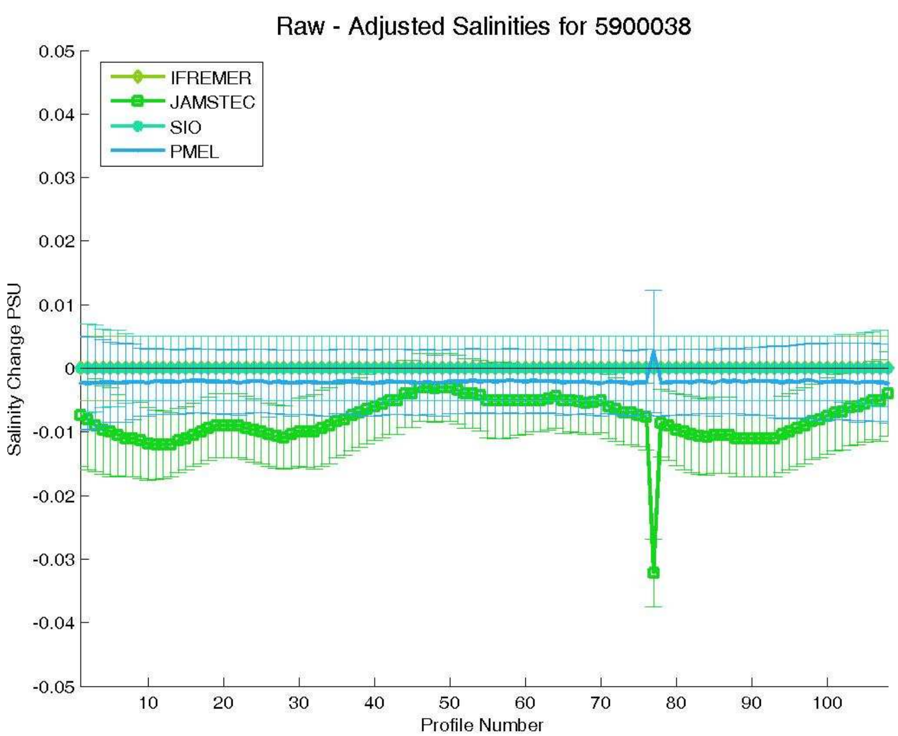


APEX in Southeast Indian Ocean. Deep T/S appears stable.
QC Flagging:

This float has salt hooks which need to have QC=3 or 4 set. Some DACs are not capturing these errors.

Salinity Drift:
This float shows little evidence of a significant bias or drift. Accordingly most DACs did not adjust this float, though JAMSTEC and PMEL both have adjusted salinties for a fresh bias.

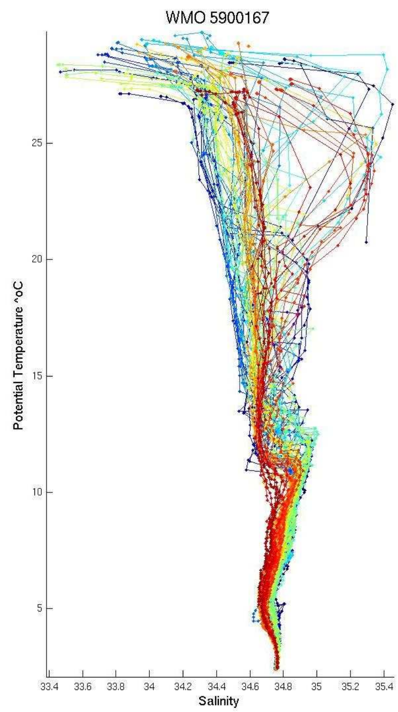

G&K anomalies on pt for 5900038
CARS/WOA 98 anomalies on pt for 5900038
Anomalies from raw float average on pt for 5900038
salinity on θ = 2.3457°C
θ °C
Profile Number
Salinity
Raw float
CARS/WOA98
G&K
GDAC

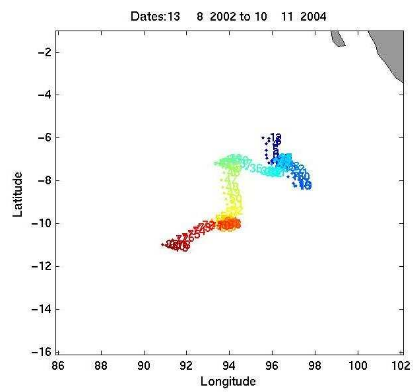

Raw - Adjusted Salinities for 5900038
IFREMER
JAMSTEC
SIO
PMEL
Salinity Change PSU
Profile Number

WMO 5900167

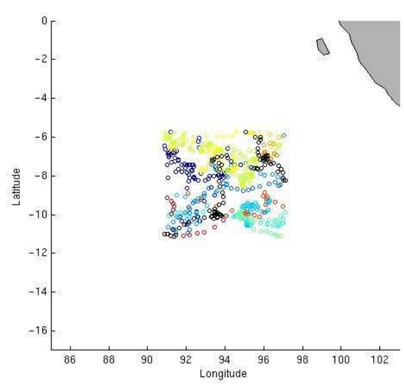
JMA PROVOR SBE JAMSTEC

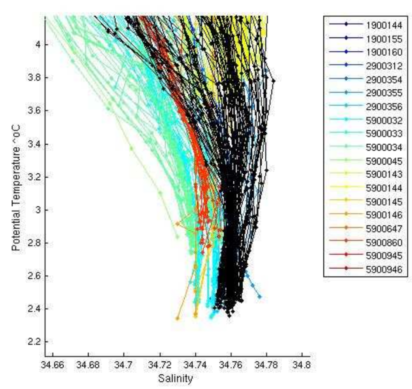
Park 2000, 2000 profile





South-east Indian Ocean data set from the Indonesian Throughflow region





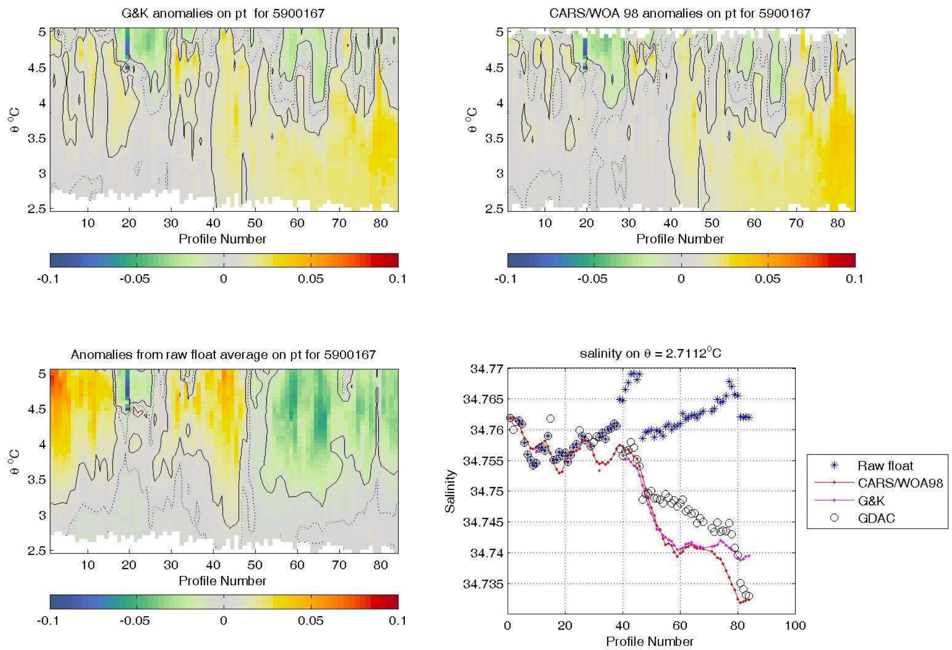
No very obvious drift, but it does lie to the salty side of nearby Argo profiles.

QC Flagging:

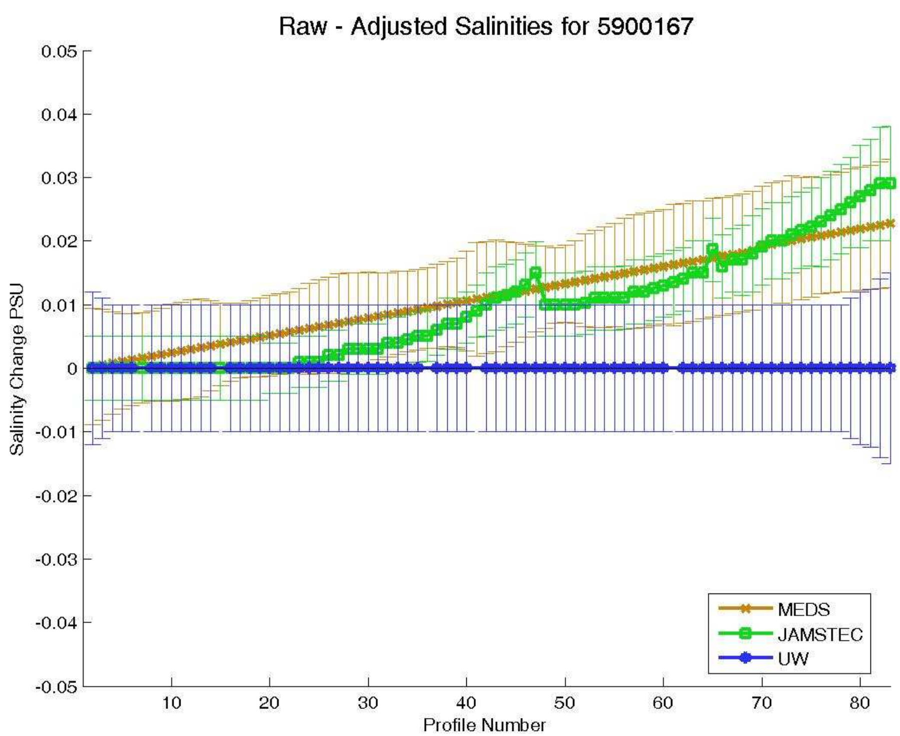
Only 2 inversions in thermocline were found – otherwise this is a very clean data set, with no obvious deep salt hooks!

Salinity Drift:

Anomalies from climatologies suggest that this float does indeed drift salty over its lifetime. This is a difficult case, as the climatology-float difference is dominated by changes in the background due to float advection.



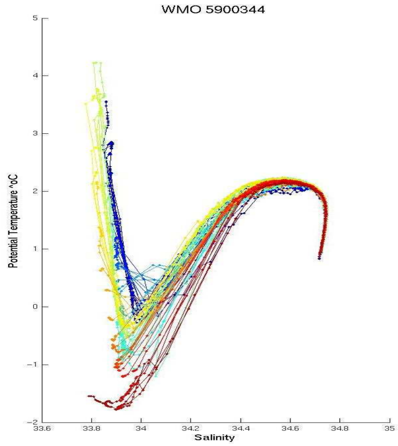
Here, most DACs assessed the sensor as drifted except UW. Where the drift was corrected, results agree within error bars.

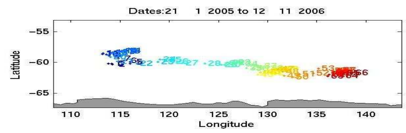


WMO 5900344

CSIRO APEX SBE Susan Wijffels

Park 1000, profile 2000

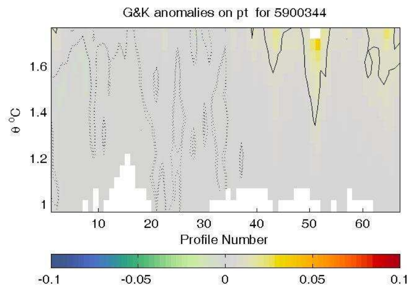


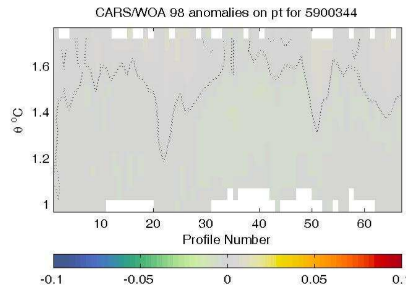


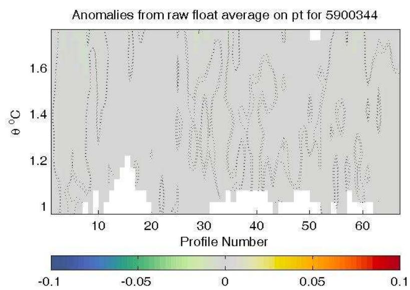
Long zonal deployment near the ice edge in the Southern Ocean.

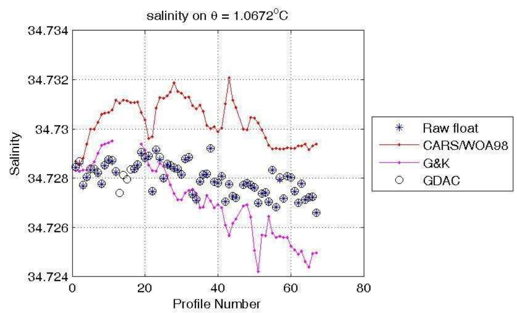
QC Flagging:
A very clean data set. Deep salt hooks on many profiles that were only picked up by a few DACs.

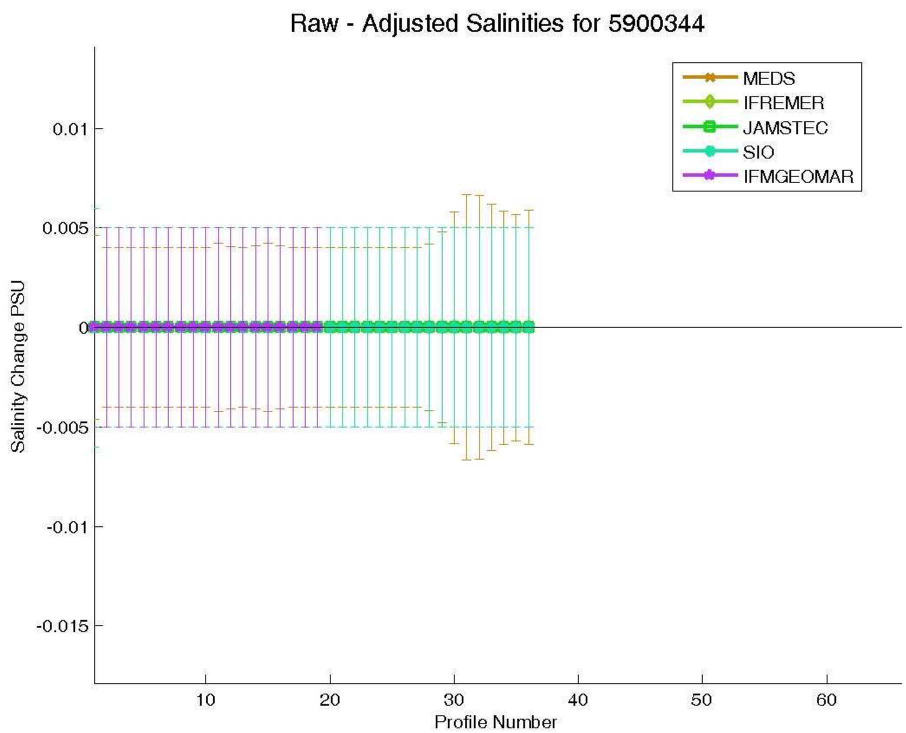
Salinity Drift:
Sensor appears very stable. No drift apparent compared to climatology. DACs that examined this float did not adjust the salinities and error bars are very small.










Raw - Adjusted Salinities for 5900344
MEDS
IFREMER
JAMSTEC
SIO
IFMGEOMAR
Salinity Change PSU
0.01
0.005
0
-0.005
-0.01
-0.015
10
20
30
40
50
60
Profile Number

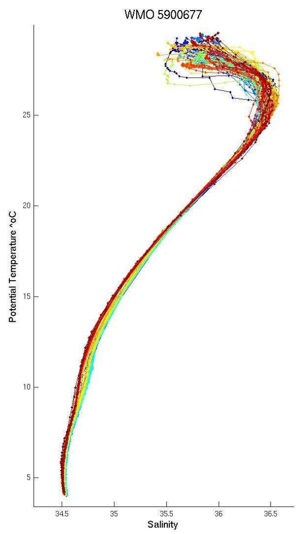
WMO 5900677

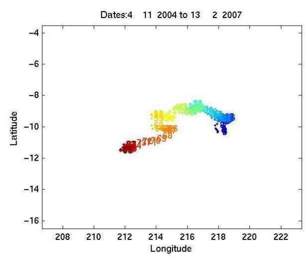
JMA PROVOR SBE JAMSTEC

Park 2000, 2000 profile

aoml SOLO SBE Dean Roemmich

Park 1000, 1050 profile

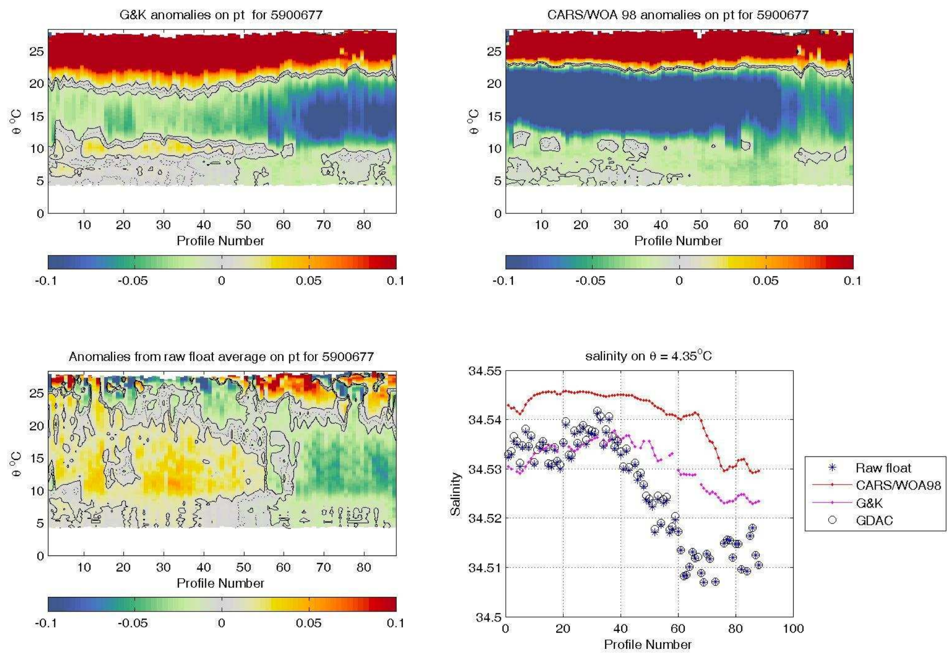




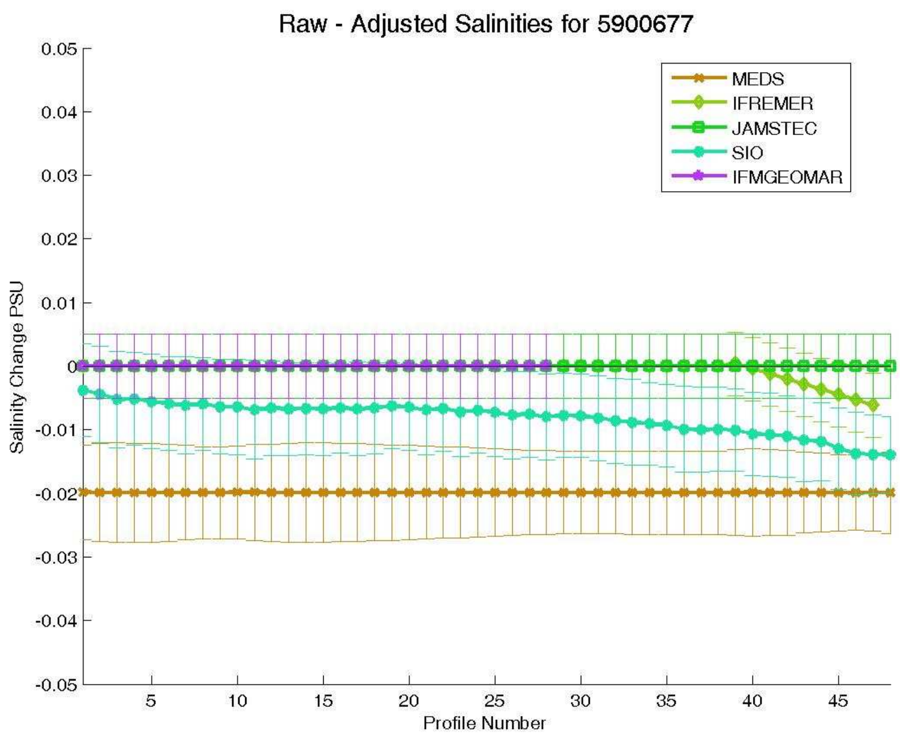
Subtropical SW Pacific Ocean – features a tight stable TS below AAIW and in Central Water, but is possibly fresher than nearby Argo

QC Flagging:
A very clean data set. No inversions/spikes

Salinity Drift:



Comparisons with climatology suggest a fresh drift in the second half of this floats life, but within the float data set itself, salinities on coldest sampled temperatures are very stable. This is a difficult call.



Several DACs chose not to adjust this float, while others assessed a fresh bias. Adjustments are nearly overlapping but not quite.

History and Comments fields

Information about the calculations applied during the DMQC procedure are recorded in the NetCDF files. These are written to dedicated fields listed in table 3 below.

HISTORY_SOFTWARE	software used for calculating the adjustments
HISTORY_SOFTWARE_RELEASE	version of the software
HISTORY_REFERENCE	reference dataset used
SCIENTIFIC_CALIB_EQUATION	equations used for calculating the adjustments
SCIENTIFIC_CALIB_COMMENT	Comments on calibration

We found important variations among the DACs in the contents and in the formatting of these fields.

The data was extracted from the profiles of five floats of the intercomparison set. The profiles sampled were those that underwent DMQC by most of the DACs. Tables 4 below provides an example of the variations in the dimensions of the history fields and Table 5 lists their contents. Fields with empty value are not shown in the tables.

The number of history items n_hist varies widely, from 0 to up to 13. (This number appears in Table 5, appended to the name of the associated field, eg HISTORY_SOFTWARE 8). Fields of dimension 0 means no information. When these fields contain no information, the user is not able to trace the adjustment procedure employed, whereas too many information items can confuse the user, particularly when many of the items contain redundant information (eg SIO on 3900132,).

Unfortunately, guidelines outlined in the Argo Data Management User's Manual do not require any particular structure for the history information, nor impose any order on the way this information appears with regard to the parameter adjusted. As a result, most DACs have entered the information into the history fields in bulk. This leads to a lack of clarity as to which history information corresponds to which parameter. For instance for float 4900238, PMEL placed into the HISTORY_SOFTWARE field three values PADJ, CTL and SIQC and into the HISTORY_SOFTWARE_RELEASE field three values V1.0, V1.0 and V2.0. One could infer that these values are related in the two series in the same sequential order. However there is some guess work, hence associated indetermination. Similarly for float 2900288, Ifremer has placed into the field HISTORY_SOFTWARE_RELEASE three version number 1, 2.1 and 2.2, but it is not clear which software exactly these numbers referred to.

2900288				
meds	sw release:	3	1	4
	reference set:	3	1	64
ifremer	sw release:	8	1	4
	reference set:	8	1	64
jamstec	software:	3	1	4
	sw release:	3	1	4
	reference set:	3	1	64
sio	sw release:	2	1	4
	reference set:	2	1	64
pmel	sw release:	3	1	4
	reference set:	3	1	64
ifmgeomar	sw release:	3	1	4
	reference set:	3	1	64
39047				
meds	sw release:		1	4
	reference set:		1	64
ifremer	sw release:	5	1	4
	reference set:	5	1	64
jamstec	sw release:		0	0
	reference set:		0	0
sio	sw release:	4	1	4
	reference set:	4	1	64
ifmgeomar	sw release:		1	4
	reference set:		1	64
3900132				
meds	sw release:	2	1	4
	reference set:	2	1	64
ifremer	sw release:	5	1	4
	reference set:	5	1	64
sio	sw release:	13	1	4
	reference set:	13	1	64

ifmgeomar	sw release:	2	1	4
	reference set:	2	1	64
4900175				
meds	sw release:		1	4
	reference set:		1	64
ifremer	sw release:	4	1	4
	reference set:	4	1	64
jamstec	sw release:		0	0
	reference set:		0	0
sio	sw release:		1	4
	reference set:		1	64
pmel	sw release:	3	1	4
	reference set:	3	1	64
ifmgeomar	sw release:		1	4
	reference set:		1	64
4900239				
meds	sw release:	6	1	4
	reference set:	6	1	64
ifremer	sw release:	8	1	4
	reference set:	8	1	64
jamstec	sw release:	6	1	4
	reference set:	6	1	64
sio	sw release:		1	4
	reference set:		1	64
pmel	sw release:	3	1	4
	reference set:	3	1	64
ifmgeomar	sw release:	6	1	4
	reference set:	6	1	64

Table 4. Dimensions of the history parameters.

2900288		
meds	HISTORY_SOFTWARE 1:	Fmtp
	HISTORY_SOFTWARE 2:	Rqcp
	HISTORY_SOFTWARE 3:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	2
	HISTORY_SOFTWARE_RELEASE 2:	2.2

	HISTORY_SOFTWARE_RELEASE 3:	2.0b
	HISTORY_REFERENCE 3:	WOD01:SeHyD:CTD WITH MIN_MAP_ERR = -1
ifremer	HISTORY_SOFTWARE 1:	fmtp
	HISTORY_SOFTWARE 2:	rqcp
	HISTORY_SOFTWARE 3:	JMQC
	HISTORY_SOFTWARE 4:	JMQC
	HISTORY_SOFTWARE 5:	WJO
	HISTORY_SOFTWARE 6:	cnvd
	HISTORY_SOFTWARE 8:	BS
	HISTORY_SOFTWARE_RELEASE 1:	2
	HISTORY_SOFTWARE_RELEASE 2:	2.2
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_SOFTWARE_RELEASE 6:	2.1
	HISTORY_SOFTWARE_RELEASE 8:	1
	HISTORY_REFERENCE 5:	SeHyD1
	HISTORY_REFERENCE 8:	WOD2001
jamstec	HISTORY_SOFTWARE 1:	fmtp
	HISTORY_SOFTWARE 2:	rqcp
	HISTORY_SOFTWARE 3:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	2
	HISTORY_SOFTWARE_RELEASE 2:	2.2
	HISTORY_SOFTWARE_RELEASE 3:	1
	HISTORY_REFERENCE 3:	SeHyD1
sio	HISTORY_SOFTWARE 1:	SIQC
	HISTORY_SOFTWARE 2:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V2.0
	HISTORY_SOFTWARE_RELEASE 2:	V2.0
	HISTORY_REFERENCE 1:	WOD2001 & Argo;
	HISTORY_REFERENCE 2:	WOD2001 & Argo;
pmel	HISTORY_SOFTWARE 1:	PADJ
	HISTORY_SOFTWARE 2:	CTL
	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V1.0
	HISTORY_SOFTWARE_RELEASE 2:	V1.0
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_REFERENCE 3:	WOD2001 & Argo
ifmgeomar	HISTORY_SOFTWARE 1:	fmtp
	HISTORY_SOFTWARE 2:	rqcp
	HISTORY_SOFTWARE 3:	BS
	HISTORY_SOFTWARE_RELEASE 1:	2
	HISTORY_SOFTWARE_RELEASE 2:	2.2
	HISTORY_SOFTWARE_RELEASE 3:	1
	HISTORY_REFERENCE 3:	COR2005
39047		
meds	HISTORY_SOFTWARE 1:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	2.0b

	HISTORY_REFERENCE 1:	WOD01 WITH MIN_MAP_ERR = -1
ifremer	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE 4:	SIQC
	HISTORY_SOFTWARE 5:	BS
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_SOFTWARE_RELEASE 4:	V2.0
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_REFERENCE 3:	WOD2001 & Argo
	HISTORY_REFERENCE 4:	WOD2001 & Argo;
	HISTORY_REFERENCE 5:	COR2005
sio	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE 4:	SIQC
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_SOFTWARE_RELEASE 4:	V2.0
	HISTORY_REFERENCE 3:	WOD2001 & Argo
	HISTORY_REFERENCE 4:	WOD2001 & Argo;
ifmgeomar	HISTORY_SOFTWARE 1:	BS
	HISTORY_SOFTWARE_RELEASE 1:	1
	HISTORY_REFERENCE 1:	COR2005
3900132		
meds	HISTORY_SOFTWARE 1:	OA
	HISTORY_SOFTWARE 2:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	3.02
	HISTORY_SOFTWARE_RELEASE 2:	2.0b
	HISTORY_REFERENCE 2:	WOD01 WITH MIN_MAP_ERR = -1
ifremer	HISTORY_SOFTWARE 1:	BS
	HISTORY_SOFTWARE 2:	BS
	HISTORY_SOFTWARE 3:	BS
	HISTORY_SOFTWARE 4:	BS
	HISTORY_SOFTWARE 5:	BS
	HISTORY_SOFTWARE_RELEASE 1:	2005
	HISTORY_SOFTWARE_RELEASE 2:	2005
	HISTORY_SOFTWARE_RELEASE 3:	2005
	HISTORY_SOFTWARE_RELEASE 4:	1
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_REFERENCE 1:	GE
	HISTORY_REFERENCE 2:	GE
	HISTORY_REFERENCE 3:	GE
	HISTORY_REFERENCE 4:	IF
	HISTORY_REFERENCE 5:	COR2005
sio	HISTORY_SOFTWARE 1:	SIQC
	HISTORY_SOFTWARE 2:	SIQC
	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE 4:	SIQC
	HISTORY_SOFTWARE 5:	SIQC
	HISTORY_SOFTWARE 6:	SIQC

	HISTORY_SOFTWARE 7:	SIQC
	HISTORY_SOFTWARE 8:	SIQC
	HISTORY_SOFTWARE 9:	SIQC
	HISTORY_SOFTWARE 10:	SIQC
	HISTORY_SOFTWARE 11:	SIQC
	HISTORY_SOFTWARE 12:	SIQC
	HISTORY_SOFTWARE 13:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V2.0
	HISTORY_SOFTWARE_RELEASE 2:	V2.0
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_SOFTWARE_RELEASE 4:	V2.0
	HISTORY_SOFTWARE_RELEASE 5:	V2.0
	HISTORY_SOFTWARE_RELEASE 6:	V2.0
	HISTORY_SOFTWARE_RELEASE 7:	V2.0
	HISTORY_SOFTWARE_RELEASE 8:	V2.0
	HISTORY_SOFTWARE_RELEASE 9:	V2.0
	HISTORY_SOFTWARE_RELEASE 10:	V2.0
	HISTORY_SOFTWARE_RELEASE 11:	V2.0
	HISTORY_SOFTWARE_RELEASE 12:	V2.0
	HISTORY_SOFTWARE_RELEASE 13:	V2.0
	HISTORY_REFERENCE 1:	WOD2001 & Argo
	HISTORY_REFERENCE 2:	WOD2001 & Argo
	HISTORY_REFERENCE 3:	WOD2001 & Argo
	HISTORY_REFERENCE 4:	WOD2001 & Argo
	HISTORY_REFERENCE 5:	WOD2001 & Argo
	HISTORY_REFERENCE 6:	WOD2001 & Argo
	HISTORY_REFERENCE 7:	WOD2001 & Argo
	HISTORY_REFERENCE 8:	WOD2001 & Argo
	HISTORY_REFERENCE 9:	WOD2001 & Argo
	HISTORY_REFERENCE 10:	WOD2001 & Argo
	HISTORY_REFERENCE 11:	WOD2001 & Argo
	HISTORY_REFERENCE 12:	WOD2001 & Argo
	HISTORY_REFERENCE 13:	WOD2001 & Argo;
ifmgeomar	HISTORY_SOFTWARE 1:	OA
	HISTORY_SOFTWARE 2:	BS
	HISTORY_SOFTWARE_RELEASE 1:	3.02
	HISTORY_SOFTWARE_RELEASE 2:	1
	HISTORY_REFERENCE 2:	COR2005
4900175		
meds	HISTORY_SOFTWARE 1:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	2.0b
	HISTORY_REFERENCE 1:	WOD01 WITH MIN_MAP_ERR = -1
ifremer	HISTORY_SOFTWARE 1:	PADJ
	HISTORY_SOFTWARE 2:	CTL
	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE 4:	BS
	HISTORY_SOFTWARE_RELEASE 1:	V1.0
	HISTORY_SOFTWARE_RELEASE 2:	V1.0
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_SOFTWARE_RELEASE 4:	1

	HISTORY_REFERENCE 3:	WOD2001 & Argo
	HISTORY_REFERENCE 4:	COR2005
sio	HISTORY_SOFTWARE 1:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V2.0
	HISTORY_REFERENCE 1:	WOD2001 & Argo;
pmel	HISTORY_SOFTWARE 1:	PADJ
	HISTORY_SOFTWARE 2:	CTL
	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V1.0
	HISTORY_SOFTWARE_RELEASE 2:	V1.0
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_REFERENCE 3:	WOD2001 & Argo
ifmgeomar	HISTORY_SOFTWARE 1:	BS
	HISTORY_SOFTWARE_RELEASE 1:	1
	HISTORY_REFERENCE 1:	COR2005
4900239		
meds	HISTORY_SOFTWARE 6:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	1
	HISTORY_SOFTWARE_RELEASE 2:	1
	HISTORY_SOFTWARE_RELEASE 3:	1
	HISTORY_SOFTWARE_RELEASE 4:	1
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_SOFTWARE_RELEASE 6:	2.0b
	HISTORY_REFERENCE 6:	WOD01 WITH MIN_MAP_ERR = -1
ifremer	HISTORY_SOFTWARE 8:	BS
	HISTORY_SOFTWARE_RELEASE 1:	1
	HISTORY_SOFTWARE_RELEASE 2:	1
	HISTORY_SOFTWARE_RELEASE 3:	1
	HISTORY_SOFTWARE_RELEASE 4:	1
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_SOFTWARE_RELEASE 6:	2.0b
	HISTORY_SOFTWARE_RELEASE 7:	1
	HISTORY_SOFTWARE_RELEASE 8:	1
	HISTORY_REFERENCE 6:	WOD01:SeHyD:CTD WITH MIN_MAP_ERR = -1
	HISTORY_REFERENCE 8:	COR2005
jamstec	HISTORY_SOFTWARE 6:	WJO
	HISTORY_SOFTWARE_RELEASE 1:	1
	HISTORY_SOFTWARE_RELEASE 2:	1
	HISTORY_SOFTWARE_RELEASE 3:	1
	HISTORY_SOFTWARE_RELEASE 4:	1
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_SOFTWARE_RELEASE 6:	1
	HISTORY_REFERENCE 6:	SeHyD1
sio	HISTORY_SOFTWARE 1:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V2.0

	HISTORY_REFERENCE 1:	WOD2001 & Argo;
pmel	HISTORY_SOFTWARE 1:	PADJ
	HISTORY_SOFTWARE 2:	CTL
	HISTORY_SOFTWARE 3:	SIQC
	HISTORY_SOFTWARE_RELEASE 1:	V1.0
	HISTORY_SOFTWARE_RELEASE 2:	V1.0
	HISTORY_SOFTWARE_RELEASE 3:	V2.0
	HISTORY_REFERENCE 3:	WOD2001 & Argo
ifmgeomar	HISTORY_SOFTWARE 6:	BS
	HISTORY_SOFTWARE_RELEASE 1:	1
	HISTORY_SOFTWARE_RELEASE 2:	1
	HISTORY_SOFTWARE_RELEASE 3:	1
	HISTORY_SOFTWARE_RELEASE 4:	1
	HISTORY_SOFTWARE_RELEASE 5:	1
	HISTORY_SOFTWARE_RELEASE 6:	1
	HISTORY_REFERENCE 6:	COR2005

Table 5. History fields and their contents.

Recommendations:

1. it is desirable that the parameter which information is entered in the history field be clearly specified.

2. where several history items is applied, it is desirable to keep number to a minimum and avoid redundancy.

Calibration equation and comments

Most DACs filled the calibration equation and comments fields with the mathematical equations and coefficients used in the calculations of the adjustements, primarily for PSAL.

Due to the volume, the contents of the calibration equation and comments are placed in a separated document attached to the appendix of this report.