REPORT ON

FOURTH ARGO DELAYED-MODE QC WORKSHOP

(DMQC-4)

CLS, Toulouse, France
28 September 2009

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Table of Contents

1) Introduction

The purpose of DMQC-4, which was held in conjunction with ADMT-10, was two-fold. The primary goal was to make use of ADMT-10 as an opportune time for the delayed-mode group to meet and resolve the un-resolved issues left over from DMQC-3. The secondary goal was to encourage delayed-mode scientists who did not regularly attend ADMT meetings to participate in the data management events in 2009.

2) Pressure correction in delayed-mode

2.1) Review of the Druck microleak problem in SBE CTDs

Annie Wong presented a brief review, on behave of Steve Riser and Dana Swift, of a problem with the Druck pressure sensor that was employed in SBE41 and SBE41CP CTDs. The problem was known as the Druck microleak. The problem was manifested as negative drifts in pressure, followed by eventual transducer failure at the end stage of the disease. The cause of the problem was identified to be oil leaks from the sealed inner sensor chamber via micro-cracks in the glass-to-metal seals. As oil leaked, the flexible titanium diaphragm, which was used to transmit seawater pressure to the oil chamber, was deflected downward. The restoring force to right the diaphragm reduced the oil pressure, which was then transduced as a negative pressure error.

At the time of DMQC-3 (September 2008), the Druck microleak problem was thought to occur in about 3% of SBE CTDs. During early 2009, analysis of combined data from BSH, UW, and CSIRO showed that both the occurrence rate and the oil leak rate had increased from what was expected prior to the analysis. According to data from UW, 28% of a batch of floats deployed in October 2008 showed the problem within the first 5 months of their lifetime.

Delayed-mode groups were thus made aware of increased likelihood of data being affected by this problem. It was estimated that 25-35% of floats deployed in 2007 and later would have the microleak defect, and with varying oil leak rates. During the initial phase of the microleak, data are still good after adjustment; however, data will eventually become erratic as the disease approaches its end stage, at which point the data are bad and unadjustable.

The ensuing discussions concerned delayed-mode quality control of pressure measurements from the various float types in Argo, with particular emphasis on detecting negative pressure errors due to the Druck microleak problem.

2.2) The APEX uncorrectables (Truncated Negative Surface Pressure Drifts – TNPDs)

2.2.1) Independent analyses that can detect suspicious floats

Druck microleaks were identified in Argo floats as a negative surface pressure drift that eventually exceeded −1 dbar. However, APEX floats that used the older APF-8 controller, as well as APF-5 and APF-7, did not report negative surface pressure values. Hence identification of microleaks in these floats was difficult.

Stephanie Guinehut reviewed her altimetry qc test as an independent analysis that could detect suspicious floats. In particular, she spoke on the limitations of the method in terms of pressure and salinity signals to be detected. The method compared co-located Sea Level Anomalies (SLA) from altimeter measurements with Dynamic Height Anomalies (DHA) from Argo T/S profiles to detect systematic errors in the Argo data set. It was found that the sensitivity towards salinity error increased with employment of deeper reference levels, while the sensitivity towards pressure error decreased with increasing latitudes. Table 1 and Figure 1 show the minimum salinity and pressure errors that can be detected respectively if 5 cm is considered to be the smallest offset to be detected between SLA and DHA. It was concluded that altimetry qc was not of much help in detecting small salinity or pressure errors. Nonetheless, delayed-mode groups were advised to pay closer attention to results from the altimetry analysis when floats were in the equatorial region between 20°N and 20°S, since the method was most sensitive to pressure errors in the tropics.

Reference level (dbar)	Min. salinity error (PSU)
200	0.3
400	0.17
900	0.08
1200	0.06
1900	0.04

Table 1. Minimum salinity error that can be detected by altimetry analysis as a function of depth of reference level.

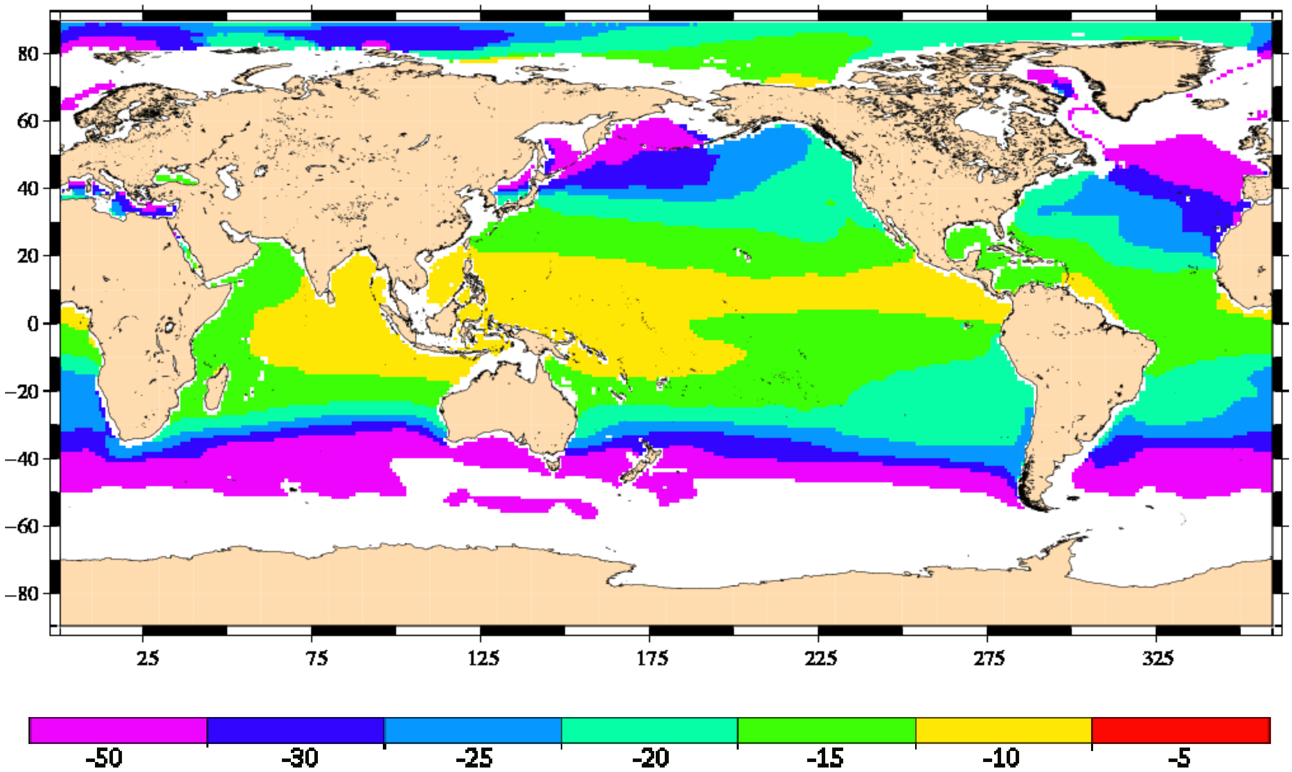

Figure 1. Geographical variation of minimum pressure error that can be detected by altimetry analysis, by using reference level of 900 dbar.

Dean Roemmich presented investigation by Megan Scanderberg on how many recent CTD data were in the reference database used for DMQC and how many recent CTD data were actually available. This study was the result of an action item from AST-10 (M. Scanderberg will work with S. Diggs to find number of co-located shipboard CTD from 2004-2008 and Argo profiles), and was also motivated by the increasing importance to have recent, high quality CTD data for Argo delayed-mode quality control because of the recent pressure offset concerns.

It was discovered that the DMQC reference database (CTD_for_DMQC2008V01) contained fewer than 200 profiles in 2004 or later, while 1,543 profiles (that sampled deeper than 1000 dbar) from 12/2003-12/2008 were available from CCHDO, and more than 15,000 from 01/01/2004-04/31/2009 were available from WOD. At the same time, some data available at CCHDO were not at WOD. It was suggested that ideally, an update for the DMQC reference database would be available each year with the cruises from both centres in the past year. More recent CTDs are needed to characterize the accuracy of Argo.

2.2.2) How to qc APEX TNPDs

The workshop then discussed how APEX floats with unknown surface pressures should be processed in delayed-mode consistently. It was agreed that for APEX APF-5, APF-7, and the old APF-8 (all controllers that truncated negative surface pressure values), when a large portion of the surface pressure time series (nominally 80%) recorded absolute zero (after the artificial 5 dbar had been removed), unknown negative pressure error should be suspected. These APEX floats were referred to as APEX TNPDs (truncated negative surface pressure drifts) and their pressures could not be adjusted. Two scenarios should then be considered.

1. When float data do not show T/S anomaly. This means that the float may be experiencing unknown negative pressure errors that are not severe. For these cases, it was agreed that the adjusted variables should receive a delayed-mode qc flag of ‘2’. That is,

   PRES_ADJUSTED_QC = ‘2’

   TEMP_ADJUSTED_QC = ‘2’

   PSAL_ADJUSTED_QC = ‘2’.

2. When float data show T/S anomaly. This means that the float is experiencing unknown negative pressure errors that are severe. A negative pressure error will cause a positive salinity drift, and a cold temperature anomaly whose size depends on the vertical temperature gradient. For these cases, the adjusted variables should receive a delayed-mode qc flag of ‘3’ or ‘4’, depending on the severity of the T/S anomaly.

   PRES_ADJUSTED_QC = ‘3’ or ‘4’

   TEMP_ADJUSTED_QC = ‘3’ or ‘4’

   PSAL_ADJUSTED_QC = ‘3’ or ‘4’.

All APEX groups were reminded that if a TNPD float began to telemeter highly erratic data, it should be treated as a sign that the float had been affected by the microleak problem, and that the disease was about to reach its endpoint. Previous cycles would then need to be reviewed.

Action 1. For APEX TNPDs, all groups to assign delayed-mode qc flags of ‘2’, ‘3’, or ‘4’ as described above.

In both scenarios, SCIENTIFIC_CALIB_COMMENT should contain the character string “**TNPD: APEX float that truncated negative surface pressure drift**”, together with any other comments the operator wishes to include, in the dimension corresponding to PRES. This is to assist users in identifying the APEX floats with unknown negative pressure errors, and whose pressures are therefore unadjustable.

Action 2. For APEX TNPDs, all groups to include the standard character string, as stated above, in the D file variable SCIENTIFIC_CALIB_COMMENT, in the dimension corresponding to PRES.

In addition, Justin Buck & Mathieu Ouellet agreed to consult their assimilation groups about how they used PRES_ADJUSTED_ERROR. Justin and Mathieu would then suggest to the delayed-mode community what value should be assigned to PRES_ADJUSTED_ERROR for APEX TNPDs to ensure that these data are treated appropriately by the assimilation groups.

Action 3. Justin Buck & Mathieu Ouellet to recommend value for PRES_ADJUSTED_ERROR for APEX TNPDs.

It was noted that CSIRO published a list of APEX TNPDs as of 8 December 2008. This list could be found on http://www.marine.csiro.au/~cow074/quota/argo_offsets.htm. This was another way by which users could identify which APEX floats had potentially unadjustable pressure errors. Users who required the highest quality data had been advised to exclude APEX TNPDs from their analyses (see http://www.argo.ucsd.edu/Acpres_drift_apex.html).

The question of pressure accuracy after adjustment was then raised. It was acknowledged that if the pressure offset was less than ~|10| dbar, the error may be independent of depth, so a simple pressure adjustment was appropriate; but if pressure offset was greater than ~|10| dbar, the error may vary with both depth and temperature. Dean Roemmich therefore volunteered to write to SBE and ask them to characterise pressure errors from Druck microleaks for the sensors they had already identified as bad in their laboratory tests.

Action 4. Dean Roemmich to ask SBE for clarification on the depth- and temperature-dependency of pressure errors from the Druck microleak problem.

2.3) The APEX correctables

Pressure measurements from APEX floats with known surface pressures are adjustable. These include APEX APF-9, the newer APF-8 that report surface pressures with negative values, and the older negative-truncating APF-8 with positive pressure errors. Procedures for adjusting APEX pressures in delayed-mode were discussed on the argo-dm-dm email forum and agreed on during February 2009. During DMQC-4, delayed-mode operators were asked whether any problem was encountered in implementing the agreed procedures for the adjustable APEX floats. No problem regarding adjustment procedures was raised, although several groups expressed concerns regarding inadequate manpower in re-processing existing D files.

2.4) Progress report from each APEX group

Each APEX group was asked to report on their progress on pressure adjustment in delayed-mode. Table 2 shows the status as of 28 September 2009. Users for whom it is important to know whether adjustment for surface pressure offset has been applied in D files must look in the variable SCIENITIFIC_CALIBRATION_COMMENT in the Argo netcdf files.

2.5) Do SOLO, PROVOR, NEMO, NINJA need additional pressure qc to detect Druck microleaks?

Other Argo float types that used SBE CTDs were reviewed.

John Gilson noted that in normal operation ranges, the SOLO model Argo floats, built and deployed by Scripps Institution of Oceanography, corrected for mild pressure drift onboard the floats by resetting the pressure sensor when at the sea surface to 0 dbar. Thus, SIO SOLO floats typically do not require additional pressure adjustments during delayed-mode processing. However, if the pressure drift between subsequent cycles is too large, as set within the floats software, the floats will not reset. In addition, in many floats that have a strong pressure drift due to the microleak problem, the needed pressure correction is not necessarily a linear offset. In these two instances, additional delayed-mode quality control is required. Typically, for both of these instances the delayed-mode task is to declare the pressure data bad (QC = '4').

Birgit Klein explained that BSH Nemo floats only recorded positive surface pressure readings. Negative surface pressure readings were truncated. The CTDs were set to the self-correction mode (reset offset).

Virginie Thierry explained that the CTS3 PROVOR and ARVOR floats also reset the pressure sensor with the “RESETOFFSET” command of the SBE41CP. Data were then truncated (-0.3 → 0; 0.6 → 0) and transmitted with a 1-dbar resolution for the CTF, CTS3, and ARVOR. With Iridium transmission and for CTS3 deployed since June 2009, data were transmitted with a 1-cbar resolution. These differences were significant when detecting the Druck microleak problem. The PROVOR CTS2 did not use “RESETOFFSET”.

Kanako Koketsu explained that NINJA floats did not transmit surface pressure. Hence, similar to the uncorrectable APEX, pressure errors in NINJA floats could only be suspected when severe T-S anomalies were evident.

APEX group (in alphabetical order)	Implemented DM PRES CORR for new D-files?	Re-processed old D-files with DM PRES CORR?	Expected date of completion
AOML/PMEL	YES	YES	N/A
AOML/UW	YES	YES	N/A
AUSTRALIA CSIRO	YES	60%	DECEMBER 2009
BODC	YES	NO	DECEMBER 2009
CHINA	NO	NO	2010?
CORIOLIS	IN PROGRESS	NO	MARCH 2010
GERMANY	NO	NO	MARCH 2010
INCOIS	NO	NO	FEBRUARY 2010
JAMSTEC	YES	YES	N/A
KOREA	NO	NO	2010?
MEDS CANADA	NO	NO	JANUARY 2010

Table 2. Status of APEX pressure adjustment in delayed-mode as of 28 September 2009.

3) CellTM correction coefficients update

Greg Johnson sent a presentation with commentary and presented, in absentia, updates on conductivity cell thermal mass correction for SBE-41 and SBE-41CP. The coefficients for CellTM correction depended on time history of temperature (hence float rise rates), and time intervals between SBE-41 spot samples. For APEX floats, the rise rate was a function of buoyancy history. A statistical rise rate had been estimated for APEX floats, but the actual individual profile speeds varied around the model. Laboratory studies were the best way to get these coefficients. Absent that, the published coefficients were the best option.

It was noted that 5 Argo groups (PMEL, Scripps, WHOI, CSIRO, JAMSTEC) had applied the CellTM correction. Other groups had not applied the CellTM correction due to uncertainty over the coefficients. Birgit Klein agreed to undertake analysis of some North Atlantic floats and to advise whether the application of CellTM correction with the currently available coefficients and estimated ascent rate improved data quality more often than degrading it.

Action 5. Birgit Klein to study effects of CellTM correction in the North Atlantic with currently available coefficients and estimated ascent rate.

4) Editing raw QC flags in delayed-mode

Virginie Thierry reviewed the discussions on editing raw qc flags in delayed-mode. This idea was first proposed during AST-8 in 2007 by Susan Wijffels and Brian King, who suggested that the man-power intensive procedure of checking pointwise errors (e.g. despiking, flagging deep hooks, correcting real-time qc errors, etc.) be made distinct from the other delayed-mode evaluation (e.g. thermal-lag correction, sensor drift re-calibration, etc.). This could be done by making the edits to the raw qc flags.

During subsequent discussions on the argo-dm-dm email forum, most people agreed that it was necessary to improve the raw flags in delayed-mode, and that new definition for PARAM and PARAM_QC was needed to reflect the new thinking on what these variables represented. In the past, Argo data were viewed as either “real-time” or “delayed-mode”. The new thinking viewed the data as either “raw” or “adjusted”, while the terms “real-time” or “delayed-mode” referred to the two stages of data quality control. Annie Wong therefore suggested new definition for PARAM and PARAM_QC as follows:

▪ PARAM contains the raw values telemetered from the floats. PARAM = PRES, TEMP, CNDC, PSAL. *(DOXY will have its own definition.)*

▪ PARAM_QC contains qc flags that pertain to the values in PARAM. Values in PARAM_QC are set initially in ‘R’ and ‘A’ modes by the automatic real-time tests. They are later modified in ‘D’ mode at levels where the qc flags are set incorrectly by the real-time procedures, and where erroneous data are not detected by the real-time procedures.

This proposed change of definition for PARAM and PARAM_QC in the Argo User’s Manual was later discussed during the ADMT-10 plenary and resulted in ADMT-10 Action Item #32.

Action 6. Annie Wong and Thierry Carval to update the Argo User’s Manual to reflect the new thinking that PARAM and PARAM_QC are 'raw', not 'real-time'.

Some rules for editing the raw qc flags were then discussed to ensure consistency among delayed-mode operators. The practice recommended by Wijffels & King during AST-8 was found to be confusing. Instead, Virginie Thierry proposed two simple guidelines:

(a). PARAM_QC should be changed to ‘4’ for bad and un-correctable data that are not detected by the real time tests; and

(b). PARAM_QC should be changed to ‘1’ or ‘2’ for good data that are wrongly identified as bad or probably bad data by the real time tests.

Action 7. All delayed-mode operators to edit the raw qc flags (PARAM_QC) in delayed-mode, to preserve pointwise information about spikes, jumps, etc, that are incorrectly flagged by the automatic real-time procedures.

A suggestion was made that if PSAL was adjusted in delayed-mode, then PSAL_QC should be ‘3’ because ‘these data should not be used without scientific correction’. Agreement was not reached on whether to instruct all delayed-mode operators to adopt this. Some groups may choose to do this if they wish.

5) How to review the delayed-mode dataset

Paul Robbins presented an overview of the need to review the Argo delayed-mode dataset, or for the delayed-mode group to conduct basin-wide analysis, internally and against other independent ocean data. Such analysis was needed to minimize potential bias created by different instrument types and different operator decisions. Another potential cause of bias was by using “good” Argo data themselves as a reference. This could create a situation where succession of small biases in the reference data slowly ratcheted the Argo delayed-mode data away from the true ocean state.

Sylvie Pouliquen pointed out that a more urgent issue was that the Argo delayed-mode dataset still contained gross errors that were not flagged properly. All groups were reminded that the user community expected the highest quality from Argo’s delayed-mode data, and therefore all delayed-mode groups should pay extra attention in editing the erroneous measurements. All groups were urged to be more receptive to results from independent analyses such as the altimetry qc test, and to correct the reported errors or re-process the D files once a complaint was filed.

6) DMQC of Argo float salinity data in the Mediterranean Sea

Milena Menna presented work done on delayed-mode qc in the Mediterranean by OGS. OGS had assembled a regional reference database for the Mediterranean, and had started delayed-mode qc on Mediterranean floats. It was found that the top 1000-dbar of the water column in some areas in the Mediterranean was too variable for statistical methods, and therefore other methods were needed to determine stability of float salinity data when floats only sampled to 1000-dbar. For floats that sampled deeper than 1000-dbar, the deeper T-S relationship could be used to compare with historical data, since the deeper (>700-dbar) T-S in the Mediterranean was relatively uniform.

As of September 2009, there were 88 floats in the Mediterranean. OGS had conducted delayed-mode qc on 40 of them. Future work was expected to continue.

7) Miscellaneous issues

7.1) D files format errors

John Gilson presented results from a set of D files format checks that he performed in September 2009 (see Table 3). Many format errors were discovered. All delayed-mode groups were asked to download Gilson’s D file format check output, and to correct their format errors accordingly. The format check output from September 2009 was available from ftp kakapo.ucsd.edu (anonymous login), cd /pub/gilson/DMQC4.

Mark Ignaszewski noted that at the time of DMQC-4, the format checker at US GDAC only checked new incoming files. Hence it would be valuable for Gilson to continue his format checks, which scanned existing D files at the GDACs. John Gilson therefore agreed to perform his D file format check every quarter on existing D files, in conjunction with updating the SIO Argo climatology.

Action 8. John Gilson to perform his D file format check on existing files every quarter, in conjunction with updating his SIO Argo climatology. Summary table is to be published in the AIC Monthly Report. Detail output is to be made available via ftp from Coriolis in conjunction with the SIO Argo climatology.

Action 9. All delayed-mode groups to download output from Gilson's D file format check, and to correct their format errors accordingly.

One particular format error that promoted some attention was the practice of some groups to substitute PARAM_ADJUSTED with FillValue where PARAM_ADJUSTED_QC = '3'. Even though this was acceptable for _ADJUSTED_QC = '4', it was not an agreed practice for '3'. Those groups were therefore asked to discontinue this practice.

Format Issues with Dmode Files

7 percent of Dmode files presently on the GDAC are formatted/filled incorrectly

Run September, 18th, 2009

DAC	AOML	BODC	Coriolis	CSIO	CSIRO	INCOIS	JMA	KMA	KORDI	MEDS
PROBLEM										
<PARAM_ADJ_QC> == '0' or ' '	196		7521	27			39	14		1540
<PARAM_ADJ> == FillValue but <PARAM_ADJ_QC> ~= '4','9'	31		5		382		23			
POSITION_QC == 0 or ' '	29	4492		1			18			
PROFILE_QC flag is not a letter (A-F)	748		70		59					
<PARAM_ADJ_ERR> variable = ' ', but <PARAM_ADJ_QC> ~= '4','9'	52		6	146	2		4854	600		1723
<PARAM_ADJ_ERROR> variable == '0'	1						2	647		
9' flag inconsistent between <PARAM> and <PARAM_ADJ>	546				29	8	172	11		143
Total	1604	4492	7602	174	448	8	5108	1272	0	3406
Percentage of Dmode	<1	100	18	6	3	<1	9	27	NaN	22

BODC (4492): Position QC == '0';
Coriolis (7521): Often entire adjusted variables left unfilled
JMA (4854): Often entire error field left unfilled;

Notes:
- I'm sure there are other formatting issues I didn't search for
- In lists/table I only recorded the first error (there might be multiple in a file)
- List available: ftp kakapo.ucsd.edu (anonymous login) cd /pub/gilson/DMQC4

Table 3. Summary table of D file format errors discovered by Gilson's format check on 18 September 2009.

7.2) Time delay in re-processing D files

Stéphanie Guinehut raised the issue that some floats that had received delayed-mode adjustments may need to be revisited due to various reasons; for example, after receiving feedback from the altimetry qc test, or after consideration of pressure problems. However, users would expect the highest accuracy once a profile file became available in D mode. The question was then asked as to what was an acceptable time delay in re-processing D files, once new problems were discovered.

All delayed-mode groups were reminded of users' high expectations of the quality of the D files. Hence whenever problems were discovered in the D files, they should be fixed as a high priority.

7.3) A dedicated DMQC webpage?

During DMQC-3, much time was spent on discussing parameter settings in DMQC software and regional water mass characteristics that were pertinent to evaluating floats for salinity sensor drift. Many delayed-mode operators were of the opinion that a dedicated DMQC webpage with summaries of such regional information, as well as related literature on climate change, etc, would be useful as a tool for sharing regional expertise between various delayed-mode groups. Sylvie Pouliquen subsequently offered to host such a dedicated DMQC webpage at the Argo Data Management WWW site (http://www.argodatamgt.org), maintained at Coriolis. During DMQC-4, many delayed-mode operators confirmed their desire to have such a webpage, and were in favour of it being password protected with user login. Mathieu Ouellet suggested employing the same login id and password that were used to access the Coriolis reference database. Annie Wong agreed to collate the basic information for the initial establishment of the webpage. The webpage was not to be an interactive site, but was to be updated statically as new information became available.

Action 10. Annie Wong to collate regional parameter information from all delayed-mode operators to form basis for a DMQC webpage. Sylvie Pouliquen to host DMQC webpage at the Argo Data Management WWW site as a user login protected page. Login id and password are to be the same as those used to access the Coriolis reference database.

7.4) Thermodynamic Equation of Seawater 2010

Brian King gave a review of the new equation of state algorithms from the Thermodynamic Equation of Seawater 2010 (TEOS-10). This was approved by IOC in June 2009 for use from January 2010 onwards. DMQC-4 reviewed the impact of TEOS-10 on the delayed-mode process, which would be small. TEOS-10 libraries are available in Matlab and FORTRAN on the TEOS-10 website (www.teos-10.org, or Google 'teos-10'); C-language libraries will come in due course. Note that the salinity argument for the TEOS-10 algorithms is Absolute Salinity:

SA =~ 1.004715 *PSAL + regional composition anomaly.

The regional anomaly arises from spatial variations in composition that change density and other thermodynamic variables, but have less contribution to conductivity and therefore do not show up properly in PSAL. This anomaly is referred to as 'delta-SA' and its magnitude is up to 0.02 g/kg. The key reasons for the community to introduce TEOS-10 include:

- TEOS-10 extends algorithms to larger parameter ranges, which were not defined for PSAL and EOS-80 ($0 < S < 120$; $T < 80$);
- more accurate treatment of the thermodynamics of ice;
- units of Absolute Salinity are proper SI units, g/kg;
- no more argument over the use of 'PSU';
- allows inclusion of delta-SA to impact density.

Temperature argument of official algorithms in the TEOS-10 code libraries is ITS-90 instead of IPTS-68. In order to use the new algorithms, PSAL must first be converted to Absolute Salinity SA, which has a regional dependence, as described above. Thus, for example, in the Matlab version of the new library ('gsw' for Gibbs Seawater library, replacing the sw_ library), the calls to calculate potential temperature would be:

SA = gsw_ASal(PSAL, PRES, LON, LAT);
potemp = gsw_ptmp(SA, TEMP, PRES, PRES_REF).

Note: **After introduction of the new TEOS-10 algorithms and the scientific use of Absolute Salinity, DACs will continue to store and serve PSAL, exactly as they do at present**. This is by analogy with temperature, where instruments report in-situ TEMP, and DACs store and serve TEMP, but scientists calculate and use the dynamically more relevant potential temperature. Floats will continue to report PSAL, calculated from CNDC according to the practical salinity algorithms of PSS-78, and DACs will store and serve PSAL. **Argo NetCDF files will not change**.

Scientists are now encouraged to calculate and use Absolute Salinity, which is a closer approximation to the mass fraction of dissolved salt. At some stage, DACs should switch from EOS-80 to TEOS-10 to perform the real-time tests on derived quantities such as density, and for DMQC. Since EOS-80 and TEOS-10 are very close in the parameter ranges of Argo data, this is expected to have zero impact on the outcome of real-time tests and delayed-mode adjustments. Switching to TEOS-10 algorithms is therefore not a priority from the point of view of Argo data flow, and can be done as part of the wider adoption of TEOS-10 in DACs' parent institutions.

Some derived quantities, in particular density, will be significantly offset if delta-SA is included. This is because the composition anomaly part of Absolute Salinity varies slowly with geographic region. Delta-SA is zero in the surface North Atlantic and greatest in the North Pacific. It is therefore critical that any data centre, Argo or otherwise, that provides its users with density data calculated from Absolute Salinity and TEOS-10 makes it clear whether delta-SA has been included, and that the users make it clear in the publications that result from those data.

7.5) Interactions between the DMQC group and the rest of the ADMT

Discussions were held on how the DMQC group could interact more with the rest of the ADMT, namely the real-time DACs, the ARCs, the AIC, the altimetry community, etc. It was noted that while the stand-alone DMQC workshops were very useful in establishing consistent delayed-mode processing procedures and exchanging regional expertise, there was a growing need for delayed-mode scientists to participate in the yearly ADMT events, in light of the fact that more regional oceanographic expertise was needed in pursuing basin-wide quality consistency in the Argo delayed-mode dataset.

While all delayed-mode operators were encouraged to attend future ADMT meetings, it was acknowledged that attendance rate would largely be dependent on funding restrictions. It would therefore be advantageous to hold future DMQC workshops in conjunction with ADMT events, when the need arose for another dedicated workshop. As usual, future DMQC workshops would be convened when a requirement for one was expressed.

Appendix – 1 Action items from DMQC-4

Action 1. For APEX TNPDs, all groups to assign delayed-mode qc flags of ‘2’, ‘3’, or ‘4’, as described in p.5 of this report.

Action 2. For APEX TNPDs, all groups to include the standard character string **“TNPD: APEX float that truncated negative surface pressure drift”**, together with any other comments the operator wishes to include, in the D file variable SCIENTIFIC_CALIB_COMMENT, in the dimension corresponding to PRES.

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Appendix – 2 List of workshop participants (in alphabetical order)

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Appendix – 3 Final adopted Agenda

Morning session (8:30 am – lunch)

1) Introduction

2) Pressure correction in delayed-mode

2.1) Review the Druck microleak problem in SBE CTDs – implications for delayed-mode qc.
Annie Wong for Steve Riser & Dana Swift

2.2) The APEX uncorrectables (Truncated Negative Pressure Drifts – TNPDs):

- Review independent analyses that can detect suspicious floats.
Stéphanie Guinehut; Dean Roemmich for Megan Scanderbeg
- How to qc APEX TNPDs? T-S analysis cannot detect pressure errors < ~|20| dbar. All APEX groups need to qc TNPD floats in delayed-mode in a consistent manner.

2.3) The APEX correctables – any problems with the agreed delayed-mode procedures?

2.4) Progress report from each APEX group.

2.5) Do SOLO, PROVOR, NEMO, NINJA need additional pressure qc to detect Druck microleaks?

2.6) How the German NEMO floats handle surface drift. ***Birgit Klein***

2.7) Surface pressure PROVOR/ARVOR floats. ***Virginie Thierry***

Afternoon session (after lunch – close)

3) CellTM correction coefficients update. *Greg Johnson*

4) Editing real-time QC flags in delayed-mode. *Virginie Thierry*

5) How to review the delayed-mode dataset – regional analysis? *Paul Robbins*

6) Delayed-mode qc of Argo float salinity data in the Mediterranean Sea. *Milena Menna*

7) Miscellaneous issues

7.1) D files format errors. ***John Gilson***

7.2) Time delay in re-processing D files; e.g. after feedback from altimetry QC. ***S Guinehut***

7.3) A dedicated DMQC website? Regional parameters & characteristics, related literature, e.g. on climate change, etc. ***Annie Wong***

7.4) Thermodynamic Equation of Seawater 2010. ***Brian King***

7.5) Interactions between the DMQC group and the rest of the ADMT: the real-time DACs, the ARCs, the AIC, the altimetry community, etc. ***Annie Wong***