7th BGC-Argo Meeting December 4-5 2018

Hervé Claustre / Ken Johnson. Introduction

Hervé Claustre presented updates of the BGC-Argo web site: the evolution of the network over the past year, a link to track new deployments of BGC floats (http://biogeochemical-argo.org/new-floats-data-table.php) and a link to follow publications related to BGC-ARGO (http://biogeochemical-argo.org/peer-review-articles-data-table.php). Also presented, good news for the network with Canadian funding allocated to support the development of the BGC-Argo program and Australian fundings allocated for a data manager and to support BGC floats. Finally, IOC adopted important decisions in summer 2018, (1) approving the current 6 core-BGC-Argo variables for global implementation under the same regime as core Argo, and (2) approving a scheme how to include other parameters into Argo. The 7th BGC-Argo workshop will focus on two main outcomes of the last year meeting: (1) the need for a global reprocessing for CHLA and BBP because of calibration issues, and (2) the need to develop synthetic profiles to help end-users and to ease working with files. Finally, two important drafts of publications were presented: BGC-Argo Best practices (Bittig et al.,), Ocean Obs 2019 (Roemmich et al.,)

Udaya Bhaskar. DAC: BGC Argo data management-India

Under Indian BGC activities of Indian ocean, INCOIS has undertaken the following activities during the period Dec, 2017 - Nov 2018:

1. Deployed 2 BGC (Provor-BioArgo floats) in the Arabian Sea and Bay of Bengal taking the tally to 53 in addition to 16 floats with only oxygen.

2. Implementing the recommendations of working group for dealing with the data from BioArgo floats data deployed by India. Many ship based measurements are being taken along with the BGC floats during deployment and these are being used for validation of profiles from BGC floats. Also profiles are being taken during all possible cruises at available BGC floats pop-up locations.

3. Worked on quality control of Chla data using remote sensing data from MODIS. This is being tested for obtaining new alpha and beta parameters to apply post factory calibration and correct the Chla profiles.

4. Utilized data of Chla, oxygen from BGC floats for studying the Noctiluca blooms in the Northern Arabian Sea and role of anti cyclonic eddies in ventilating oxygen to oxygen minimum zone in the Bay of Bengal which are published.

Violetta Paba. UK Status Report for BGC-Argo

The UK operates or has operated APEX, NAVIS, PROVOR and Deep ARVOR floats with a range of BGC sensors, totaling 51 deployed, and another 4 planned. No data is currently being delivered in v3.1, with the exception of 13 PROVOR floats that Coriolis are processing on BODC's behalf. However, BODC is very close to handling all raw data and delivering real-time core files from a significant subset of the UK BGC fleet. Moreover, BODC has been trialing shared software to QC DO data, and made advancements using MBARI SAGE-O2. They have been improving their knowledge and understanding of BGC sensors, data management and QC techniques, and attended the Biogeochemical Profiling Float Workshop at the University of Washington in July 2018. The BODC funding situation will be stable for the next few years, allowing for significant progress towards independent data management of the UK BGC fleet, and enhancement of QC techniques. BODC is seeking to collaborate with other DACs, especially with advancing and developing pH QC methods which will be its next focus.

Kensaku Kobayashi. DAC: BGC Argo data management-Japan

Japan has deployed 89 BGC Argo floats since 2005. About 15,000 B-profile files were submitted to GDACs. 9 BGC Argo floats were deployed after last ADMT meeting. Submission of B-profile files including CDOM and NITRATE data to GDACs has begun, but these data have not put through RTQC yet. They will implemented RTQC according to BGC QC manual and will also start sending oxygen data to GTS in BUFR format.

Jenny Lovell. DAC: BGC Argo data management-Australia

Currently there are 16 live out of 77 deployed BGC floats, mostly with only oxygen sensors. All BGC floats are processed in Real Time but the BGC parameters are not calibrated. DOXY data is calibrated in DMQC using a method based on Takeshita (2013) using either climatology or CTD data.

BGC-Data, including both raw and derived parameters, is delivered to GDACs in format version 3.1 BR files. BD files are delivered to GDACs with DOXY in Dmode and other BGC parameters in Rmode.

New funding has been granted by the Integrated Marine Observing System for 3 year funding, $2M (AUD), beginning early 2019. This project will engage a new full-time employee (UTas). Deployment and Real Time processing will be integrated with the core program managed by CSIRO. DMQC capability to be enhanced and our preference is to use and contribute to community tools for DMQC of all BGC parameters. Deployment priorities will be chosen to enhance the BGC array and contribute to core Argo, possibilities are Tasman Sea (southern East Australia Current) and the Southern Ocean.

Henry Bittig and Birgit Klein. BGC Argo data management - Germany

Henry Bittig reports that most of the 77 German BGC floats deployed are O2-equipped only. Three floats, equipped with O2 and pH, are currently active. They are part of a pilot between BSH and GEOMAR to explore synergies between the ICOS program (surface pCO_2, global 2D maps) and the BGC-Argo program (pH, global 3d maps).

Anh Tran / Catherine Schmechtig. DAC: BGC Argo data management-Canada

Canada currently has 25 inactive Argo floats with Aanderaa Optode 3830 and 19 Argo floats with SBE63 DOXY sensor. Currently, only 9 Argo floats with SBE63 DOXY sensor are actively report. For 2017-2018, Canada didn't deploy any float with DOXY sensor. With respect to real-time data management, floats equipped with DOXY sensor are automatically processed in the same way as core Argo. The data are subjected to real-time quality control tests described in Argo Quality Control Manual for Dissolved Oxygen Concentration. The data are distributed on the GTS in BUFR format and to the GDACs in NetCDF version 3.1.

For delayed mode data management, 6 floats equipped with Aanderaa Optode 3830 have been visually QCed. 5 floats had DOXY adjusted using Johnson et al., method and D files are available at the GDAC. The doxy data for the sixth float is un-adjustable due to poor data quality. 7 floats equipped with SBE63 Doxy sensor have been visually QC, but the data haven't been adjusted.

For 2019, Canada plans to deploy 5 NKE floats equipped with Aanderaa Optode 4330 sensor. Government of Canada recently announced of the investment of 5.6 million in support of the implementation of the BGC Argo Array over the next four years.

In July 2018, a Provor CTS5 float equipped with CHLA, CDOM, BBP, radiometry and a Nitrate sensor which was deployed July 2017, in the framework of the Greenedge project, popped out of the ice. It was recovered as it hit the ice and was damaged. The float was programmed to accelerate its cycle before emerging and this feature worked well.

Thierry Carval , Catherine Schmechtig. DAC: BGC Argo data management-France

The Coriolis data processing chain for Argo and BGC-Argo data and metadata is continuously being improved. It is freely available (http://doi.org/10.17882/45589). If needed, a compiled version can be provided (java binary, no matlab license).

In November 2018, 53,509 BGC-Argo cycle files from 409 floats were available on Coriolis DAC. In 2018, the BBP and the CHLA manuals were updated (http://dx.doi.org/10.13155/39459, http://dx.doi.org/10.13155/35385). The 28,000 BBP/CHLA files were reprocessed during summer 2018. In 2018, the Oxygen manual was updated (http://doi.org/10.13155/39795). The 42,000 oxygen files were reprocessed during autumn 2018.

In January 2019, the European project EA-RISE will start. It is dedicated to the evolution of the Core-Argo mission as well as to the BGC extension. Using deep learning DMQC techniques to improve the Argo dataset overall quality, set up and sustain the European BGC-DAC and test new BGC sensors are part of the different work packages.

In the framework of the BGC data management, preliminary work is performed by the LOV in collaboration with the Coriolis DAC to set up the data management for the UVP6-LP sensor. This sensor is an imaging sensor that measures the size and abundance of the particulate matter (>100µm) as a function of depth (6000m), with the ECOpart application (http://ecotaxa.obs-vlfr.fr/part/) it can also perform plankton and large particles identification (> 500µm).

The BGC-Argo DAC will strengthen with the recruitment of a data analyst for BGC delayed mode at the LOV (Laboratoire Oceanographique de Villefranche).

Xiaogang Xing. DAC: BGC Argo data management -China

In 2018, 9 floats were deployed: 2 didn't work at deployment, one stopped working after 3 months. they were equipped with CHLA, BBP, IRRADIANCE, NITRATE and DOXY sensors. In 2019, China plans to deploy 20 BGC floats (12 are floats equipped with DOXY (Provor CTS3); 2 equipped with CHLA, BBP, IRRADIANCE, NITRATE and DOXY sensors (Provor CTS4); 4 equipped with CHLA, BBP, IRRADIANCE, NITRATE, DOXY and PH sensors (Full-equipped for all six core BGC variables), two Provor CTS3, and 2 Navis-SL1 with temperature rechargeable battery SeaTREC).

Regarding data management:

1. CHLA: The factory calibration is applied, the Roesler factor is not yet, the CHLA spike test should be precise in the documentation to know how to process the end points.
2. BBP: The correction of the factory slope is implemented.
3. NITRATE: Ken Johnson clarifies that the wavelength used for the NITRATE concentration computation is a tuning parameter, so users can adjust its value. Catherine Schmechtig (by email after the meeting) clarifies that the format used in the NETCDF attributes is dedicated to « printing » tools, like ncdump and doesn't affect the parameter stored in the file. This attribute can be changed by each DAC and is ignore by the checker.

Tanya Maurer. DAC: BGC Argo data management-US

The workflow of the US BGC floats is presented. The total number of US BGC-floats is 378 all equipped with DOXY, 122 with pH, 131 with CHLA and BBP, 167 with NITRATE, 130 are still active in 2018. In 2018, 27 BGC-floats were deployed.

Regarding data management:

1. CHLA: factory calibration, Roesler Factor, Xing 2012 for NPQ
2. BBP: factory calibration slope update
3. pH, NO3, O2: Operational implementation of new spike test
4. pH: processing and QC documentation written
5. meta.nc and Btraj.nc are ongoing work with AOML

<u>Tanya Maurer.</u> SOCCOM data stream

The SOCCOM project in few numbers is 20 cruises, 132 floats, hydrographic stations at all deployment locations, 113 active floats, 21 floats under ice. SOCCOM floats improve our understanding of the regional carbon flux, help evaluate Earth Systems Models in the Southern Ocean. During the hydrographic stations, CTD, Winkler Oxygen, Nitrate, pH/alkalinity, HPLC, POC, FLBB mounted on Rosette measurements were acquired (underway $p\mathrm{CO_2}$, Salinity, DIC, Oxygen on CTD and other nutrients when available). Hydrographic stations are used mainly for validation and not direct calibration (almost entirely GO-SHIP cruises to maintain standards and accuracy).

<u>SOCCOM floats processing :</u>

- 6 times a day at MBARI
- Data are transferred to the GDAC twice a day
- The Floats are « refreshed » every 5 cycles (bad sensor list, update QC, modification of calibration)
- Twice a year the SAGE tool is used to adjust data

<u>Quality control and Errors:</u>

- QC=3 for data after RTQC
- a New Spike test is proposed for DOXY, pH and NITRATE

  TestValue(TV)=ABS(V2-MEDIAN[V0,V1,V2,V3,V4])

  A point is considered as a spike if TV exceeds :

  - 40 µmol/kg (DOXY)
  - 0.04 (pH)
  - 5 µmol/kg (NITRATE)
- QC=1 for data after adjustment with SAGE tool.
- DMQC Additionnal efforts
  - Visual inspection (ODV)
  - Comparison to model (BSOSE M. Mazloff, LIR, CANYON-B)
- Filling ERROR fields
  - DOXY_ADJUSTED_ERROR = DOXY_ADJUSTED * 0.01
  - PH_IN_SITU_TOTAL_ADJUSTED_ERROR = 0.01
  - NITRATE_ADJUSTED_ERROR = (abs(NITRATE - NITRATE_ADJUSTED)) * 0.1 + 0.5
  - CHLA_ADJUSTED_ERROR = abs(CHLA_ADJUSTED * 2)
  - BBP700_ADJUSTED_ERROR = empty (no adjusted data!)

Sage Tool :

The SAGE tool is freely available at https://github.com/SOCCOM-BGCArgo

First the SAGE O2 tool is used to correct DOXY as it influences pH and NITRATE adjustments.

Three methods are presented in the GUI to evaluate the DOXY parameter :

- In air measurement compared to NCEP reanalysis
- Comparison to shipboard data
- Comparison to WOA (%saturation)

Some drift trends have been pointed out on in situ optodes so a method to take into account this drift in the SAGE tool is presented. The improvement on the dataset corrected of the drift is done by comparison with bottle data.

Correction for pH and NITRATE: Basic Approach:

- Compare deep float data to model estimates over time
- Use depth of ~1500m (assumed stable)
- Use MATLAB "SAGE" GUI to derive adjustments (offset, drift)
- Akaike Information Criteria (AIC) or Bayesian Information Criteria (BIC) used to prevent over-correction of data
- Apply corrections derived at depth to entire profile
- Evaluate accuracy → compare to shipboard data
- Evaluate long-term stability → compare to GLODAPv2

Henry Bittig. Scoop tools

Henry Bittig presents the SCOOP tool developed by Ifremer/Coriolis https://doi.org/10.17882/48531. It is designed to perform visual quality control for Argo NetCDF data files and works with C-files as well as B-files. It can modify the QC flags per profile, per point, per range of depths and it populates the HISTORY section.

A proposed workflow for DM can be:

1- SCOOP visualisation of the BR-file to check the consistency of the RTQC and to remove residual outliers (set QC=4) or reset QC for falsely flagged data in RT (remove QC=4)
2- Estimate trends on the clean data set with tool like SAGE or SAGE-O2 for example
3- Write out the updated BD-file with ADJUSTED and ERROR fields filled
4- Final point-wise check with SCOOP
5- Submit the BD-file

Henry Bittig, Raphaelle Sauzède : Towards the end users

towards our customers, towards a global array : Mathieu Belbeoch

The discussion is about how can we communicate to help in going from a pilot project to a global array for BGC-Argo. We have to develop our customers contacts (health of the ocean, carbon cycle, modellers, fisheries…). According to Mathieu Belbeoch, professional communiquant should be required.

Another suggestion is to prioritize some sensor « less » expensive and easy to use to build the global array. A BGC-Argo float is expensive because of the price of the sensors (no competition between manufacturers).

For a country, deploying floats in its EEZ is really easier than for other countries or in others areas and should be encouraged as a starting point for a new contributor for the BGC-Argo program.

Countries largely involved in BGC-Argo program won't only populate their own EEZ as they want to address specific scientific questions, but this could be organized at the international level, for example the Austral ocean has been populated internationally. The Seattle meeting report (where people want to seed floats) could be a good starting point and will be sent to Mathieu Belbeoch.

Another suggestion is to think of the BGC-Argo array as part of an integrated system (and think of synergies between different systems).

New products : Raphaëlle Sauzede

BGC-Argo and Argo-derived products will be provided to the end-users as part of the European CMEMS service (Thematic Assembly Center MULTIOBS). Two different sort of biogeochemical products will be delivered: 1) Nutrients vertical profiles estimated from BGC-Argo floats measuring oxygen using the CANYON-B method and 2) yearly and monthly global 4D databases of CHLA and POC derived from merged Argo profiles with satellite ocean color data.

Synthetic profiles : Henry Bittig

Henry Bittig reminds the benefits of setting up a synthetic profile, which was an outcome of the 6th BGC-workshop: co-locate as many BGC observations as possible, same data appearance for the entire network.

The files are available here: ftp://ftp.ifremer.fr/ifremer/argo/etc/argo-synthetic-profile/ and the documentation https://doi.org/10.13155/55637 explaining the processing and the format.

During the discussion, it is mention that there will be an update to incorporate in the S-file the high resolution CTD data. After an overlap period of coexistence of M-files and S-files, the S-files will finally replace the M-files.

Ken Johnson : Open questions

What do we do with BGC data that have not been QC'd or Adjusted for more than 2 years?

In the past, it was difficult to test data processing changes on the whole BGC fleet because of uneven QC. That is changing!!! We have to carry the improvements in flagging data on to producing Adjusted data useful for science applications.

Testing RT and DM processing changes with the whole fleet

Proposal: With improved flagging of raw data, it is now possible to test new data processing procedures on large (near 100%) of the BGC fleet for many variables.

We should not accept new processing changes that apply to state variables without testing them across the fleet.

Are we properly assigning data as Delayed Mode?

The discussion is based on a decision that was reached last year which is "when correction coefficients are obtained with an operator intervention and applied to past profiles, those past profiles should be considered as Delayed Mode profiles".

Ken Johnsons objects that according to John Gould, senior AST member, the delayed mode should be reserved for the highest quality data, and not data adjusted roughly.

Another opinion is that the Delayed Mode is define as "the best we can do at a certain time". There can be several revisions of delayed mode data (float by float analysis, analysis of the whole life of the float, regional analysis …), iteratively improving with time.

The proposition made by Annie Wong is that BGC people should specify their own definition of the Delayed Mode to explain users what they can expect from the data.

Do BGC floats require a high quality bottle cast at deployment?

Assessment and Recommendation:

1. A hydrocast is not necessary for a BGC profiling float to produce high quality data.
2. Data from hydrocasts are very valuable to assess the quality of the adjustment process.
3. It is recommended that, where possible, a hydrocast with high quality data be collected to validate the adjusted data.
4. Programs are encouraged to make a significant (perhaps 50%) number of their deployments from ships making high quality measurements of variables observed by floats.

Antoine Poteau : Reprocessing

Antoine Poteau presents the status of the dataset after the reprocessing of the BBP700 and the CHLA.

BBP :

Last year in Hamburg, Andrew Barnard explained that there is a need to correct all the calibration slope factors of all ECO backscattering sensors to avoid discrepancies at depth observed in Poteau et al., 2017. All the calibration corrections of the BBP slope factor have been gathered in a single synthesis file available here (http://doi.org/10.17882/54520), arranged by DAC, WMO, SENSOR_MODEL, serial number and wavelength. This correction is no longer necessary for ECO sensor calibrated after June 2018 and/or ECO sensor with serial number higher than 5090.

We have try to keep track of the reprocessing by using comment in the PREDEPLOYMENT_CALIB_COMMENT, but this field can be correctly filled even if the serial number doesn't appear in the synthesis file, so the consistency check should be done carefully. For some Indian floats and Australian floats the reprocessing is still in progress but the improvement on the dataset is already obvious as the differences between different types of sensor have been reduced.

CHLA :

The reprocessing of the chlorophyll-A concentration was highly recommended for the whole fleet after the publication of Collin Roesler's paper (https://doi.org/10.1002/lom3.10185). Antoine Poteau tracked the reprocessing in the SCIENTIFIC_CALIB_COMMENT and also checked that the median value of the CHLA_ADJUSTED was divided by 2. For most of the DAC processing CHLA_ADJUSTED, the work is done, but there is still room for improvement.

Antoine Poteau / Emmanuel Boss / Josh Plant. BBP

Antoine Poteau highlights the improvement of the BBP dataset after the reprocessing accounting for calibration corrections provided by Andrew Barnard from SeaBird. The range has been improved both at surface and depth. As there is no proposition for a specific adjustment to fill the BBP700_ADJUSTED field, the question is raised : « what should be the next step ? ».

A suggestion is to perform a validation of the dataset with ocean color in order also to estimate the ERROR field. Then after a visual inspection the PARAMETER_DATA_MODE for BBP can be moved to D.

The documentation will be updated to specify how to fill the SCIENTIFIC_CALIB_xxx section to inform users that the ADJUSTED field is filled without any adjustment on purpose.

The BBP calculation is derived from PSAL and TEMPERATURE, we have to build a kind of « decision matrix » to illustrate how error on PSAL and TEMPERATURE impacts on the calculation of the BBP (same for other parameters : NITRATE, DOXY…). Brian King adds that there is probably a batch of floats for which PSAL will fail prematurely and much earlier than BGC sensors. This will need alternative methods to get salinity data (e.g., using climatological PSAL).

Xiaogang Xing / Emmanuel Boss / Josh Plant. Chlorophyll-A

Xiaogang Xing presents the background to perform quality control on Chlorophyll-A

1. A linear relation between Fluorescence of CHLA and CHLA concentration is expected
2. The factory calibration is function of the mono-culture of phytoplankton used to calibrate and should be refine to match with in-situ phytoplankton.

   So, one should take care of :

1. The dark correction of the signal should be carefully addressed because of the change of dark current of the sensor once plugged on floats
2. The Non-Photochemical Quenching (NPQ) which occurs at day time is one of the reason why the relation between fluorescence of chlorophyll-A and the concentration of cholorophyll-A is no longer linear.
3. The slope of the factory calibration

All these issues have been addressed in the actual RTQC procedure but should be refined for the DM procedure.

For the Dark Correction the propositions are :

1. Keep RTQC dark correction
2. On float measurement (OFM) performed by the manufacturer or an operator once the sensor is plugged on the float
3. Median of all Minima (MAM) for each float
4. Minimum-offset correction (MOC) for each profile

For the NPQ Correction the propositions are :

1. Keep Xing 2012
2. Xing 2018 based on irradiance
3. Josh's method based on estimated euphotic layer depth (z_eu) for other percentage light level (like 2% or 5%)

For the Slope Correction the propositions are :

1. On-board-based correction (1. Water sampling at deployment, 2. CHLA determined by HPLC or fluorometry, 3. linear regression between CHLA and FCHLA, after Dark and NPQ correction without intercept to get slope)
2. Satellite-based correction (1. Match-up between float and Satellite CHLA product, 2. Ratio between OC-CHLA and FCHLA (after Dark and NPQ correction) => slope, 3. Slope=median(all slopes))
3. Irradiance-based correction (e.g. Xing et al., 2011)

Josh Plants explains that he takes into account the recommendations of the last ADMT,

<u>RAW DATA (CHLA)</u>

- CHLA = (Fluorescent Counts – Dark Counts) * Scale Factor
- CHLA_QC = 3

<u>ADJUSTED DATA (CHLA_ADJUSTED)</u>

- 1st 5 profiles > 900m?
- if YES determine In situ Dark Counts = median of profile minimums (any depth)
- Instrument bias correction: Float CHLA * 0.5 (Roesler et al. 2017)
- Correct for NPQ on median filtered profile (Xing et al. 2012)
  pad edges with raw, dp >3m bin = 3, otherwise bin = 5
- Add "spike data" back to profile (not NPQ corrected!)
- Set adjusted QC flags to 5 for NPQ corrected data
  QC flag for the rest of CHLA data 2 (?)

Adding the spikes back to profile without accounting that they are also affected by the quenching is not satisfactory (a suggestion is made to weight the spike with the quenching effect: get the ratio between the spike and the baseline when the quenching occurs and keep this ratio between the values corrected and the spike so that it could be considered as the spike corrected of the quenching)

No decisions were taken, the overall discussion highlights the fact that every new method proposed should be tested over the whole fleet and illustrated with statistics.

Tom Trull adds that data stream correction / processing steps should move to a strict declination on the three levels:

a. Get the instrument noise / calibration right -> get good total fluorescence Ftot
b. Use (deep) in situ darks to remove FDOM for Ftot to get zero level of chlorophyll fluorescence -> get good chlorophyll fluorescence FChl
   (Challenges: e.g., FDOM is not constant with depth, etc.)
c. Convert FChl to Chl a concentration -> get good chlorophyll a concentration
   (Challenge: FChl – Chl a conversion, affected by many biological processes/adaptations, e.g., NPQ)

<u>Xiaogang Xing / Antoine Poteau</u>. Radiometry

<u>RT_QC : Antoine Poteau</u>

Antoine Poteau presents a proposition of quality control for radiometric data based on a range test. This range test should be an easy way to remove maximum and minimum outliers. The downwelling irradiance below the surface is calculated from the Gregg and Carder model (Gregg and Carder 1990), then extrapolated from 0 to 10m using the Kd of pure sea water from Morel and Maritorena model (Morel and Maritorena 2001).

Compute_DOWNWELLING_IRRADIANCE = DOWNWELLING_IRRADIANCE* exp(Kd *depth)

Then, the median between 0 and 10 m is calculated and multiplied by a factor to get:

Range_Max = median(Compute_DOWNWELLING_IRRADIANCE(0,10))*1.5

Range_Min = median(Compute_DOWNWELLING_IRRADIANCE(0,10))*0.001

If the median of values of the profile between 0 and 10 meters is under the Range_Min or above the Range_Max the QC of the whole profile should be set to 4.

Applied on the whole fleet, the percentage of profiles with QC 4 depends on the wavelength of the measurements but for the worst case (412nm), this percentage doesn't exceed 1.5 %.

The recommendation is to put QC=0 for night profiles, but alternate QC=0 and QC=1/4 for the time series could be confusing for the user, so an alternative solution must be studied.

DM_QC: Xiaogang Xing

Xiaogang Xing proposes a dark signal correction in delayed mode for radiometry. This correction should correct the temperature dependence of the dark signal, the delay time coefficient response and the heat conduction effects illustrated with an OCR-solo sensor equipped with an inner temperature sensor.

We present how the DM correction coefficients could be estimated:

1. Fixing delay time coefficient (Δt = 54s) and response coefficient (k = 0.19/min)
2. Retrieving A and B for each channel of each sensor based on night profile preferably in late summer (with a linear regression between the DARK COUNT and the sensor temperature (estimated with Δt and k))
3. Tracking drift in A over time with near-1000 m data (e.g. drift mode)

Then, to submit DM file, we should apply A, B, Δt, k and Temperature profile to correct all OCR504 dark values to estimate ADJUSTED values.

Kenneth Johnson / Henry Bittig. Oxygen

Processing

Henry Bittig published an overview on optodes (https://doi.org/10.3389/fmars.2017.00429) and updated the BGC-Argo documentation. The emphasis is on the importance of the PARAMETER_ACCURACY definition which is directly linked with the type of optode and its factory calibration ("plug & play" accuracy when using an O_2 optode).

There is a reminder that the optode pressure response is potentially changing with time at high pressures but it is hard to distinguish if there is a drift in the optode response or in the pressure response over time.

A typo was discovered in the B2 exponent in the documentation (now B2=-0.0103410 / before B2=-0.00103410), but the effect is very small and according to Henry, it doesn't require a complete BGC-Argo DOXY fleet reprocessing. The documentation was corrected.

RT and DM adjustment

The accuracy of the measurements depends on the individual calibration of the sensor and on the proximity of calibration or reference data to the deployment. To allow the scientific use of DOXY data an in-situ adjustment of DOXY (in RT or DM) is crucial.

A RT adjustment is proposed to remove a systematic low bias. It recommends to adjust DOXY with a gain (no offset, no temperature correction) with the WOA O2 percentage saturation at surface. If no delayed mode adjustment is proposed after one year, a computation of the median gain factor over one year should be done.

For DM adjustment, Henry recalls that to perform in-air adjustment, the carry-over (in-water O2 affects the in-air measurements), the temperature compensation and an in-situ drift (even if it is less than the storage drift) should be taken into account.

The decision at the last ADMT to store the in-air measurements (PPOX_DOXY measurements) in the Btraj is presented (Traj code).

- X–10 = in-water samples, part of end of profile, shallower than nominal 10 dbar
- X+10 = in-water samples, part of surface sequence (guidance in RT: before air-bladder inflation / before max. buoyancy)
- X+11 = in-air samples, part of surface sequence (guidance in RT: after air-bladder inflation / after max. buoyancy)
- X–1 = individual surface observations

As repeated calibrations and field data indicate a non-zero change at 0 O2. It is recommended to apply a constant uncertainty for error estimates for the entire O2 range (instead of an uncertainty that scales with DOXY).

Several tools are available to perform DM for DOXY (Sage-O2 (Tanya Maurer) or LOCODOX (Virginie Thierry)). In addition to DOXY adjustments, the time response of the optode should also be addressed (with timestamp or assuming a mean float ascent velocity as input) as well as removing the hook at the base of the profile (first 50 dbars).

Ken Johnson / Catherine Schmechtig. Nitrate

NITRATE (Ken Johnson)

132 floats are equipped with NITRATE sensors

A QC test should be added when BISULFIDE is present as the NITRATE is biased (QC=3 ?) for example in the Black sea.

NITRATE Adjustment in RT (Catherine Schmechtig)

Catherine Schmechtig presents the adjustment method in RT that was adopted at Coriolis in 2018. It is based on an adjustment of the NITRATE measured by the float at 1000m on the WOA database reference. This method will be improved with the use of a dedicated version of CANYON (Neural Network) for the marginal seas (ex : Mediterranean sea). A version independent of DOXY concentration is also expected.

Ken Johnson / Henry Bittig. pH

120 floats with pH

pH (Ken Johnson)

The documentation with the processing, the RTQC and the adjustment method was released in 2018.

https://doi.org/10.13155/57195

The SAGE tools is presented to illustrate how it can be used to derive offset and gain for the pH adjustment. (See also Tanya Maurer presentation on SOCCOM). The validation is done by comparison with bottle data.

DM for pH (Henry Bittig)

- A pump offset occurring around 750dbar between pH spot sampling and continuously-pumped sampling is highlighted on two different floats in the Labrador Sea
    - Why, what is the physical/scientific reason?
    - What should we do when this pump offset is changing with time?
- By comparison with CANYON-B, sometimes an offset (relatively independent of depth) is pointed out
    - What should be the reference depth?
    - Least variable part of the pH/theta curve (same as OW method)
    - Use several reference depths
- By comparison with CANYON-B, sometimes a drift is pointed out

Ken adds that a pump offset is seen on many SOCCOM floats, too. It is likely caused by a "streaming potential" of the sea water (spot sample: strong pumping for 2.5 s, then pump no longer on when pH sample is measured; CP sample: weakly pumped @ ca. 10 mL/s, pump is always on, incl. during pH sample).

pH with ISFET sensor (Dave Murphy)

The principles of the pH measurements is reminded and intercalibration exercises with MBARI are presented.

- The pH at 2000m can be used to assess sensor drift (At this depth pH should remain relatively constant)
- The stability of the pH sensor is better than 0.005 pH over a 9 month deployment.

Open Questions: What to fill in the ADJUSTED_ERROR fields?

After a short discussion, agreement is reached that values in the adjusted error fields should (in general) correspond to a 1 std. deviation / 68 % confidence level. Providing a 1 std. deviation error is in line with practice for climatologies.