7\textsuperscript{nd} Biogeochemical-Argo Workshop
December 4-5 2018, San Diego

Introduction
Hervé Claustre & Ken Johnson
Biogeochemical-Argo – Development

Roots in Optics
Ocean Color Community

Roots in Chemistry
Dissolved Oxygen

Broad Community Interest & Support

Joining Efforts
Science Plan and Implementation Discussion

• US Ocean Carbon & Biogeochemistry Scoping Workshop, 2009, Moss Landing, USA
• IOCCG WG on Bio-Optical Sensors on Argo Floats
• SCOR WG 142 on QC Procedures for $O_2$ and other BGC Sensors on Floats and Gliders
• Various Community White Papers (OceanObs’09)
• Technology Maturation and several small/medium Scale Pilots and Regional Deployments

Planning for a Global Network Meeting
11-13 January 2016, Villefranche-sur-Mer, France
Science & Implementation Plan

**Research Topics**
- Carbon Uptake
- OMZs and Nitrate Cycling
- Acidification
- Biological Carbon Pump
- Phytoplankton Communities

**Management Topics**
- Living Marine Resources
- Carbon Budget Verification

**6 Core BGC-Variables**
- $O_2$
- $NO_3$
- pH
- Chl $a$
- Suspended Particles
- Downwelling Irradiance

**BGC-Argo Global Network Design**
- 1000 Floats Array Size (0.25x core-Argo)
- Deployment of ~250 Floats / Year for sustained Operation
- ~27M USD / Year for sustained Operation
- **Data Management following Argo Standards**
Fundamental decision for the global implementation of BGC-Argo

Evolving capabilities of the ARGO profiling float network

The Executive Council,

I. Global implementation of six new biogeochemical parameters on Argo floats

1. Having examined the evolving capabilities of the Argo profiling float network and the planned global implementation of sensors to measure six new biogeochemical parameters described in IOC/EC-LI/2 Annex 9 Section II,

2. Recognizing the contribution of Argo to measurement of GOOS Essential Ocean Variables, and the potential scientific and societal benefits of the global measurement of the six new biogeochemical parameters,

3. Appreciating Argo's pioneering free and open data policy, in compliance with the later IOC Oceanographic Data Exchange Policy (IOC Resolution XXII-6),

4. Approves the global implementation of Argo floats measuring these six parameters—oxygen, pH, nitrate, chlorophyll, backscatter, and irradiance; and

5. Agrees to the continued use of IOC's Guidelines for the Implementation of Resolution XX-6 of the IOC Assembly Regarding the Deployment of Profiling Floats in the High Seas within the Framework of the Argo Programme (IOC Resolution EC-XLI.4) for notification to coastal Member States of all Argo profiling floats likely to enter their EEZ, including those measuring these new variables;

6. Recognizing the value of Argo for responding to global challenges on climate variability and change and its role in underpinning ocean and marine services, encourages all IOC Member States to further support and participate in the implementation of the Argo programme, and to facilitate the deployment of Argo floats within their areas of national jurisdiction.
II. The approval framework for additional new parameters for Argo

7. Having examined the proposed approval framework for additional new parameters for Argo described in IOC/EC-LI/2 Annex 9 Section III,

8. Notes that experimental new parameters on Argo floats will be tested through individual national research programmes, in a manner consistent with UNCLOS;

9. Agrees that the Argo Steering Team can designate *Argo approved pilot parameters* based on requirements of: technological readiness; a compelling global design and implementation plan; and the potential to deliver major benefits to research and societal services; for deployment under Argo's notification regime (IOC Resolution EC-XLI.4) and under Argo's free and open data policy for a limited period of time allowing for scientific evaluation of the results; and

10. Requests the Argo Steering Team and the GOOS Steering Committee to bring the results of Argo-approved pilots to an IOC governing body for approval before moving to a stage of global implementation.
BGC-Argo network evolution over one year

Operational Floats (292)
- Suspended particles (148)
- Nitrate (94)
- Downwelling irradiance (54)
- Chlorophyll a (148)
- pH (74)
- Oxygen (283)

Total Profiles
- 155,676
- 2017
- 28,768
- 2018
- 9,311
- 2017
- 60,021
- 2018
- 59,117
- 2018
- 28,863
- 2018

Profiles Acquired by
- 313 sensors in 2017
- 135 sensors in 2018
- 104 sensors in 2017
- 209 sensors in 2018
- 209 sensors in 2017
- 209 sensors in 2018
- 60 sensors in 2018

Generated by www.jurateq.org: 07/11/2017
### Biogeochemical Argo

#### Tracking new deployments

**FLOAT DEPLOYMENT HISTORY**

<table>
<thead>
<tr>
<th>WMO</th>
<th>PROJECT Name</th>
<th>PI Name</th>
<th>SENSORS</th>
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Some good news for the network…

Funding secured for BGC-Argo floats and a data manager
US-OCB Biogeochemical Float Workshop, Seattle WA, July 9-13
BGC-Argo publications

2018


Several discussions and outcomes from last BGC-Argo Workshop

- **Data format**: balance between complex/large files but closer to the reality of the sampling.......vs other “aligned” format, more easy to use (key for end-users) but less close from the reality of the measurement

- **R, A vs D modes** for BGC-Argo data

- **Reprocessing issues**
  - Whole data base reprocessing due to sensors issues (bbp, Chla) clearly identified in peer review literature
  - Objective to provide more rapidly science-quality data to end users.

- Converge to **produce documentation** processing and RT–QC procedure for the 6 core variables
New challenges for BGC-Argo reprocessing the (global) dataset

• The more we acquire data the more we highlight potential issues
  – $b_{bp}$ (Poteau et al., 2017): calibration
  – Chla (Roesler et al. 2017): calibration (+regional variability)

• First time for the BGC-community envisage a whole and global reprocessing, thanks to Argo policy (ocean remote sensing)

• **Reprocessing has been done.**
  =>We need to discuss not only of the results but also of the method we used “collectively” (as various DACS) and of the potential improvements.
Data format issues

• Certain files format (too?) complex and large (high resolution) but closer to the reality of the sampling….

• ...vs other “aligned” format, more easy to use (key for end-users) but possibly slightly less conform to the reality of the measurement

• We have to find the balance to guarantee future reprocessing and reinforce the building of the end user community

• **Synthetic files have been proposed** and are produced...

  =>We need to discuss more of the format (and products) for end-users (our best BGC-Argo advocates)
We need to discuss and agree on a shared nomenclature /signification with respects to the A & D modes.


# Documentation status

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| Legend     | Done                | On-going              |


Bittig et al. : BGC-Argo best Practices contribution (March)

1. Pre-deployment / lab : Sensors + platforms
2. At sea procedures
3. Data management & distribution
4. Data usage

Roemmich et al. On the future of Argo: An enhanced global array of physical and biogeochemical sensing floats (submitted)
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Thanks!

For all presenters: please send 5-10 line summary of your presentation to Catherine and myself before the end of the meeting.
Being efficient in our discussion actions

• Try to converge on as many topic as we can.
• If not (i.e. some complementary studies required), identify / agree on a group of person who will interact (skype / email) before OSM/AST) and make appropriate decision
• Launch the subsequent actions in spring
Data format

- For Multiprofile M-files, Netcdf4 for Coriolis large files will partially solve the issue for storage and transmission.
- New single profile M-file will be managed by “2.5” format for alignment: Thierry + Catherine + Henry + Annie + Josh.
- *How to report flag on this new aligned file.*
QC of data: RT, NRT & DM

- `<PARAM>_QC` flag: 3 for all 5 core BGC-variables except radiometry (2)
- Develop (visual) grey list and implement it as soon as you have (flag 4)
- Develop RT tools (e.g. neural-network based) to identify the obvious flag 4 / bad profiles => objective to be on the monthly report
- Visual, tool-assisted control (e.g. SAGE)
  – DM even if it is done on a routinely (~ weeks-month) basis
- SAGE tool to be distributed. Produce the correction file (breakpoints for offset, drift, gain) to be implemented by DACs for O2, pH and NO3.
- Proposition of BD file not waiting D for core file.
Chla recommandations

Night profiles
• Step 1: Identify the minimum on the Chla profile (5 first profiles in water > 900 m) and use it to correct to baseline
• Step 2: Apply the 0.5 correction factor (Roesler et al. 2017)

Day profiles
• Repeat step 1 & 2
• Keep the present QC NPQ (Flag 5) (Xing 2012) ADMT procedure for the A-mode
• SOCCOM –MBARI have an additional D-mode where they provide users with NPQ corrected

Strategy for improvement on present NPQ correction based on light:
• Assemble data set (day & night profile)
• Test improvement of Xing methods with additional absolute (modeled, measured) or relative (Zeu) irradiance and other (e.g. Sackman) methods.
**bbp recommandations**

- \( bbp \): implement of the cal/file metadata + serial number.
- keep factory dark
- Andrew Bernard (Seabird) distributes the correction matrix to be verified by DACs
- The correction file is available at a unique repository, where?
- Process factory dark + slope at the same time
- Keep trace of the change in the new netcdf file (predeployment_calib_XXX : date + reference)
- Finish the \( bbp \) processing AND the QC document: Emmanuel + Giorgio
O₂ recommandation

• When DOXY is not associated with CTD samples, the DOXY is stored in one single N_PROF.
• Measurement code 1100 for in-air data removed, instead relative codes for in-air sequence
• Initial real time adjustment using WOA at surface (perspective: use in-air data for automatic adjustment at DAC)
pH

• pH reference measurement:
  Spectrophotometric (+ purified or un-purified dye) vs (DIC + Alk)-derived pH
• Regional dependence of both measurements
• These issues / uncertainties clearly explained in the document.
• Bottle pH corrected to in situ Temperature.
• Publish the processing and QC document
NO 3

- Update the pressure dependence according to the Sakomoto’s paper
- Publish the processing and QC documents
pH & NO3

• SAGE => Correction for D mode (backwards) and A mode (forwards)
• Automatic adjustment
  – CANYON, O2-based estimate of deep reference measurement
  – If O2 not available use WOA (or GLODAP) as initial reference
  – Including conservative accuracy_error estimate
• Both processes documented in the QC documentation
Radiometry

• Publish the processing document
• Write QC document
  – Based on clear sky model (+ wave focusing)
• Continue refining temperature dependence (DM)
Miscellaneous

• Need file / products (L3/L4) for end-users (survey to the community?)
• Hosted link by Argo/BGC-Argo to access

• Put parameter_data_mode into the index file
• Importance of filling the error_field (and to document how is it calculated; where?)